



# ► Plastics and the world of work

## ▶ Session objectives

**At the end of the session, you will be able to:**

1. Identify the properties and types of plastics.
2. Understand the global plastics market.
3. Recognize the environmental consequences of plastics.
4. Describe how workers may be exposed to hazardous chemicals during all stages of plastic's lifecycle.
5. Explain how chemical additives and microplastics can have an adverse effect on worker health.
6. Suggest key priority actions at both policy and workplace levels to protect workers from harmful chemical exposures from plastics.



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# Introduction to plastics



## ▶ Introduction to plastics

- ▶ Plastics are found in **all aspects of modern life**, including the **world of work**.
- ▶ Their **flexibility**, **durability** and **strength** have made them indispensable components of **billions of modern products**, with an ever-widening range of applications (*PACE n.d.*).
- ▶ At current rates, plastic packaging volumes are expected to **more than quadruple** by 2050 to **318 million tonnes per year** (*World Economic Forum 2016*).



## ▶ Introduction to plastics and worker health

### ▶ **Plastics contain and leach hazardous chemicals.**

- ▶ These chemicals have been linked with **cancers, birth defects** and impairments to the **immune, endocrine** and **reproductive systems** (*Rustagi et al. 2011*).
- ▶ This has serious implications for the **world of work**, where workers in numerous industries are exposed to plastics every day.
- ▶ In the plastics industry alone, millions of men and women work through its entire value chain, from **production** to **transformation, collection** and **recycling**.
- ▶ Many are in the **informal economy**, where **occupational safety and health (OSH) regulations** and **social protections** are extremely limited.

## ▶ Introduction to plastics and pollution

- ▶ Plastics pollution has become one of the **most important environmental issues** globally.
- ▶ Plastics have been found on the summit of Mount Everest and in the deepest oceans.
- ▶ Over **300 million tons of plastic are produced every year**, half of which is used to create **single-use items**, such as shopping bags, cups and straws (*IUCN 2021*).
- ▶ In developed countries, **low recycling rates predominate**, with even greater issues existing in the developing world, where rubbish collection systems may be **inefficient or non-existent**.

## ▶ Understanding the issue

- ▶ Whilst the impact of **plastic pollution** is widely publicized, the adverse impacts of plastics exposure on **worker health** should now also be considered a priority.
- ▶ Action is needed to **protect workers** around the world, who are at risk of **debilitating chronic conditions** from plastics exposure.
- ▶ Developing effective strategies to ensure **safer** and more **environmentally sound work practices** is essential for protecting both workers and the planet.





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▶ **What are plastics?**





## ▶ What are plastics?

- ▶ A **group of polymers**, either **synthetic** or **naturally occurring**, that can be moulded into solid objects of various shapes.
- ▶ Mostly derived from **fossil fuel-based chemicals**, such as natural gas, coal or petroleum, although some come from **renewable biological substances**, such as vegetable fats and oils.
- ▶ Plastics can be divided into two categories (*Halden 2010*):
  - **Thermostats**: A polymer that solidifies irreversibly when heated and is therefore useful for their **durability** and **strength**. Used in automobiles, construction, adhesives, inks and coatings.
  - **Thermoplastic**: A polymer in which the molecules are held together by weak bonds and can therefore be **easily shaped** and moulded into products. Used in milk jugs, floor coverings, credit cards and carpets.

## Question:

Can you identify any properties of plastic which make it so useful?



## ▶ Properties of plastics

- High strength to weight ratio
- Lightweight
- Water/weather resistance
- Low cost
- Chemically stable
- Easily moulded into shapes
- Flexible
- Good electrical insulators
- Low thermal conductivity
- Durable
- Available in a variety of colours, both opaque and transparent
- Clean and shining, so don't need painting or polishing

## ▶ The six major polymer types

- ▶ 70% of global production is concentrated in **six major polymer types**.
- ▶ These can be identified by their **resin identification code (RIC)**.
- ▶ Polyurethanes (PUR) and polyester, polyamide and acrylate polymers (PP&A) are often also included as major commodity classes, although lack RICs as they are chemically diverse.



Polyethylene terephthalate (PET or PETE)



High-density polyethylene (HDPE or PE-HD)



Polyvinyl chloride (PVC or V)



Low-density polyethylene (LDPE or PE-LD),



Polypropylene (PP)



Polystyrene (PS)

# Plastic Resin Identification Codes

						
<b>PETE</b> Polyethylene Terephthalate	<b>HDPE</b> High-Density Polyethylene	<b>PVC</b> Polyvinyl Chloride	<b>LDPE</b> Low-Density Polyethylene	<b>PP</b> Polypropylene	<b>PS</b> Polystyrene	<b>Other</b>
<b>Common Products:</b> <ul style="list-style-type: none"><li>• water bottles</li><li>• soda bottles</li><li>• peanut butter jars</li></ul>	<b>Common Products:</b> <ul style="list-style-type: none"><li>• milk jugs</li><li>• 5 gal buckets</li><li>• shampoo bottles</li><li>• laundry detergent containers</li></ul>	<b>Common Products:</b> <ul style="list-style-type: none"><li>• vinyl</li><li>• tubing/pipe</li><li>• siding</li><li>• auto product bottles</li></ul>	<b>Common Products:</b> <ul style="list-style-type: none"><li>• laundry baskets</li><li>• bread bags</li><li>• squeeze bottles</li><li>• plastic film</li></ul>	<b>Common Products:</b> <ul style="list-style-type: none"><li>• yogurt containers</li><li>• amber-colored pill bottles</li><li>• coffee cup lids</li><li>• straws</li><li>• kitty litter buckets</li></ul>	<b>Common Products:</b> <ul style="list-style-type: none"><li>• styrofoam cups</li><li>• solo cups</li><li>• egg cartons</li><li>• to-go containers</li></ul>	<b>Common Products:</b> <ul style="list-style-type: none"><li>• toys</li><li>• sippy cups</li><li>• cd/dvds</li><li>• lenses</li></ul>
						

Source: Greenpeace 2020

# Common polymers and their uses

<p><b>Polyethelene</b> (PE)</p>  <p>Plastic bags, storage containers</p>	<p><b>Polypropylene</b> (PP)</p>  <p>Bottle caps, rope, gear, strapping</p>	<p><b>Polystyrene</b> (PS)</p>  <p>Utensils, cups, floats, coolers, containers</p>	<p><b>Polyamide</b> (nylon) (PA)</p>  <p>Rope, fishing nets, textiles</p>	<p><b>Polyester</b> (PES)</p>  <p>Textiles, boats</p>
<p><b>Acrylic</b> (AC)</p>  <p>Latex paint, coatings, medical devices</p>	<p><b>Polyoximethylene</b> (POM)</p>  <p>Automotive parts, electronics</p>	<p><b>Polyvinyl alcohol</b> (PVA)</p>  <p>Laundry detergent pods, fishing bait</p>	<p><b>Polyvinyl chloride</b> (PVC)</p>  <p>Pipe, film, containers</p>	<p><b>Poly methyl acrylate</b> (PMA)</p>  <p>Laminated safety glass (e.g. car windshields)</p>
	<p><b>Polyethelene terephthalate</b> (PET)</p>  <p>Drink bottles, textile fibers</p>	<p><b>Alkyd</b> (AKD)</p>  <p>Resins, paints</p>	<p><b>Polyurethane</b> (PU)</p>  <p>Ship varnish, construction, automotive parts</p>	

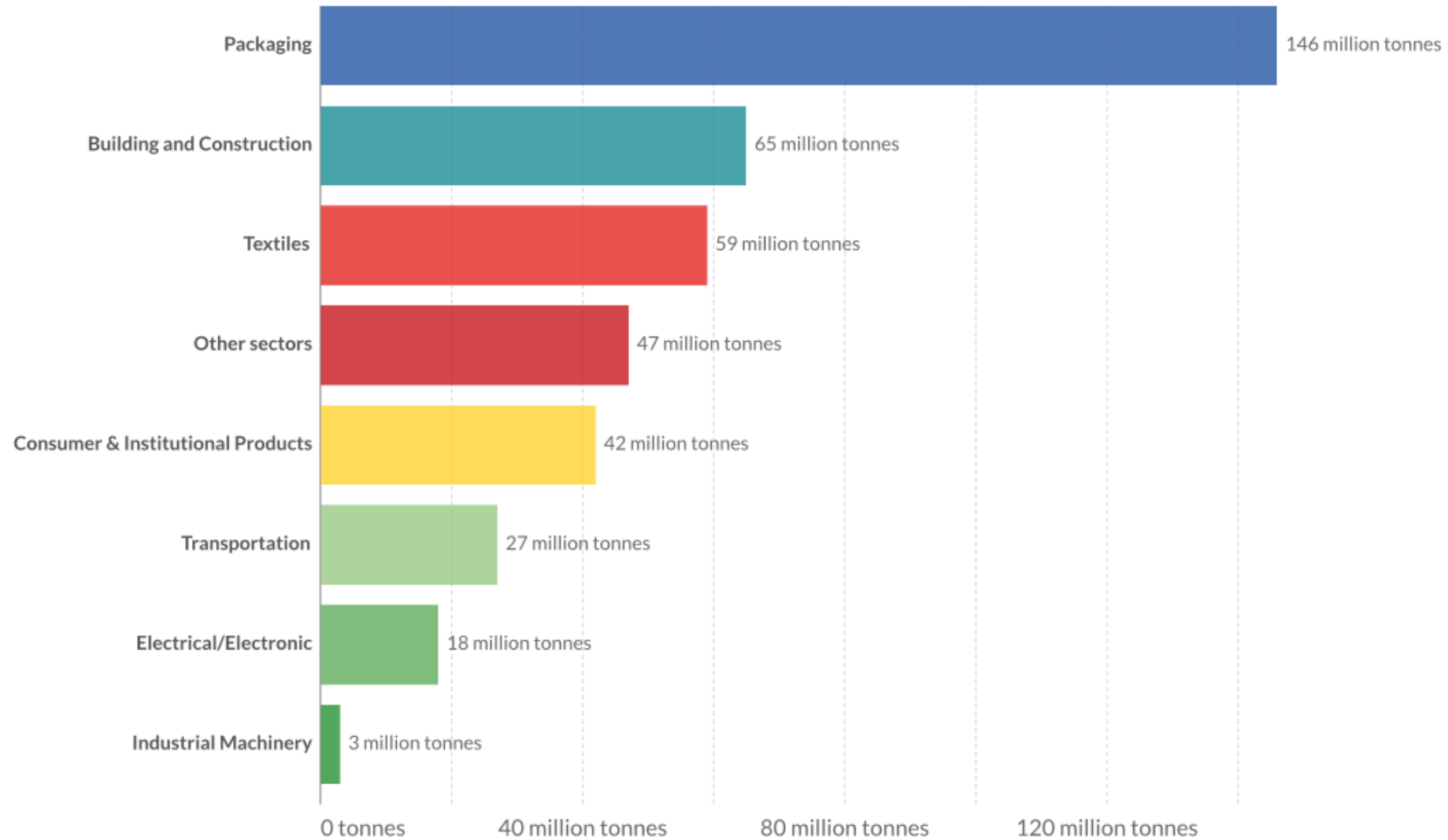


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# Global plastics production

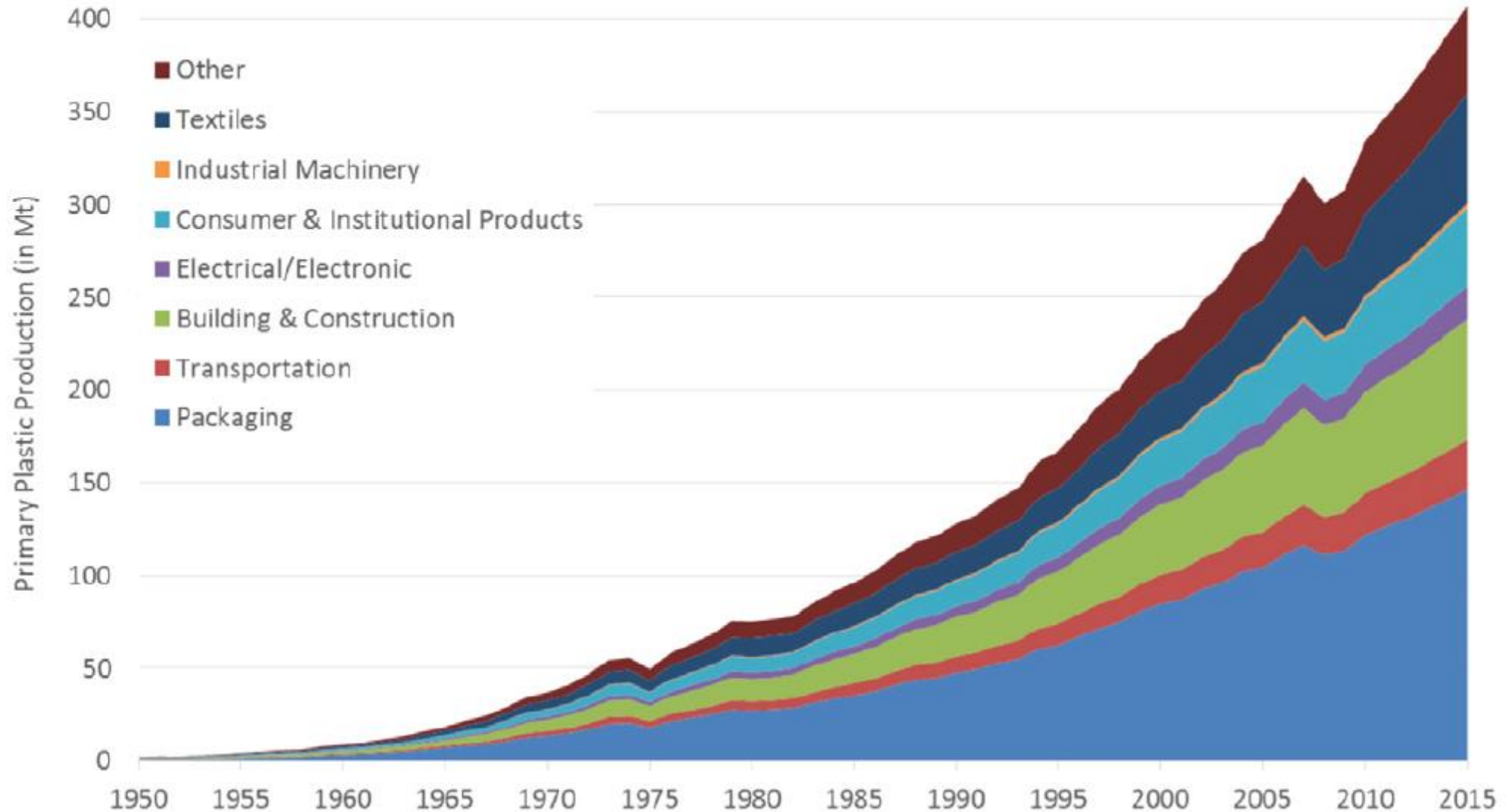


# Primary plastic production by industrial sector, 2015





# Global primary plastics production according to industrial use sector from 1950 to 2015 (million metric tons)

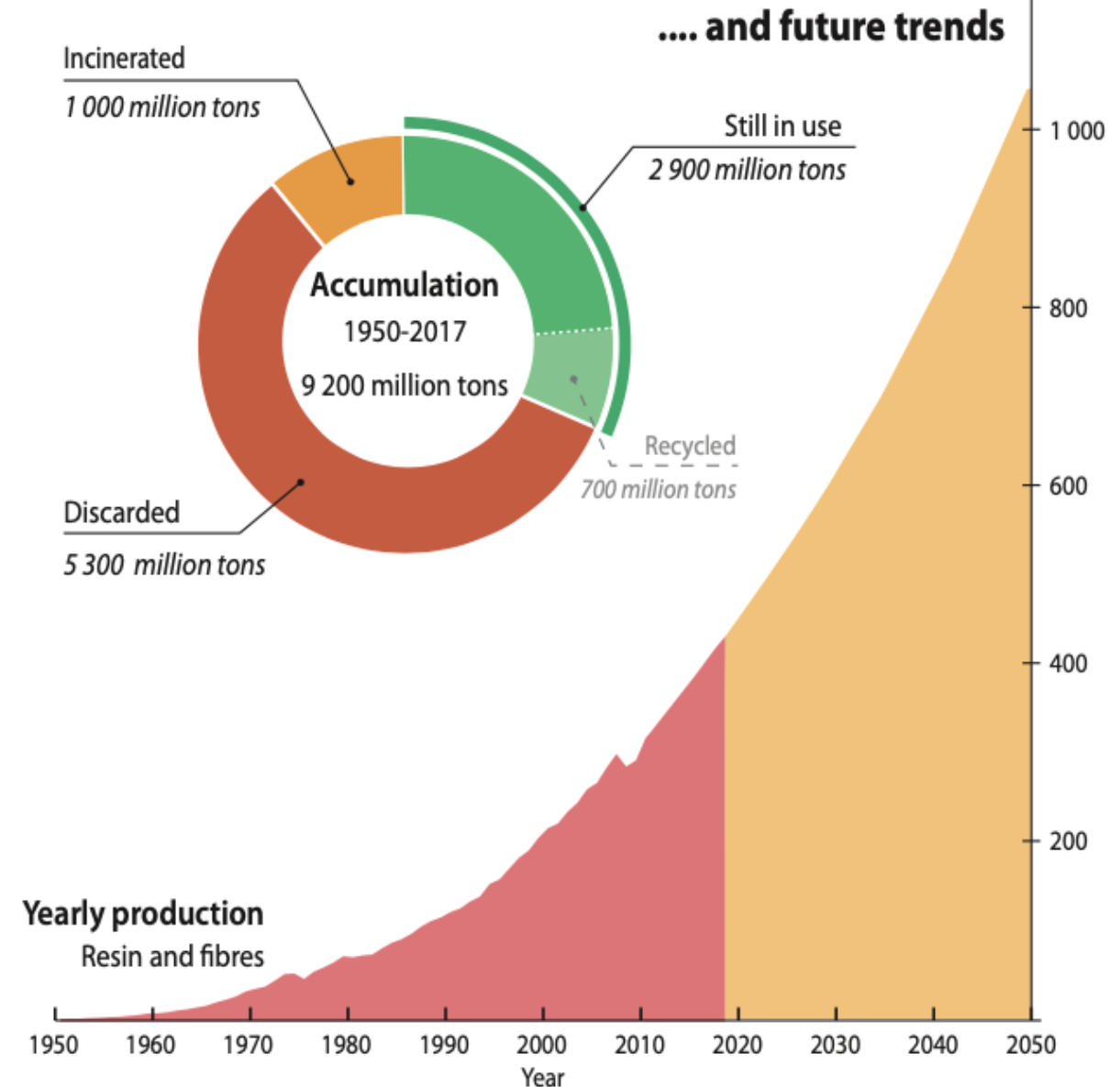


Source: UN 2019

# Global plastics production, accumulation and future trends

- ▶ Cumulative global production of primary plastic between 1950 and 2017 is estimated at **9,200 million metric tons**.
- ▶ It is forecast to reach **34 billion metric tons** by 2050 (*Geyer 2020*).
- ▶ Of the **7 billion tons** of plastic waste generated globally so far, **less than 10% has been recycled** (*Geyer 2020*).

## Global plastic production and accumulation

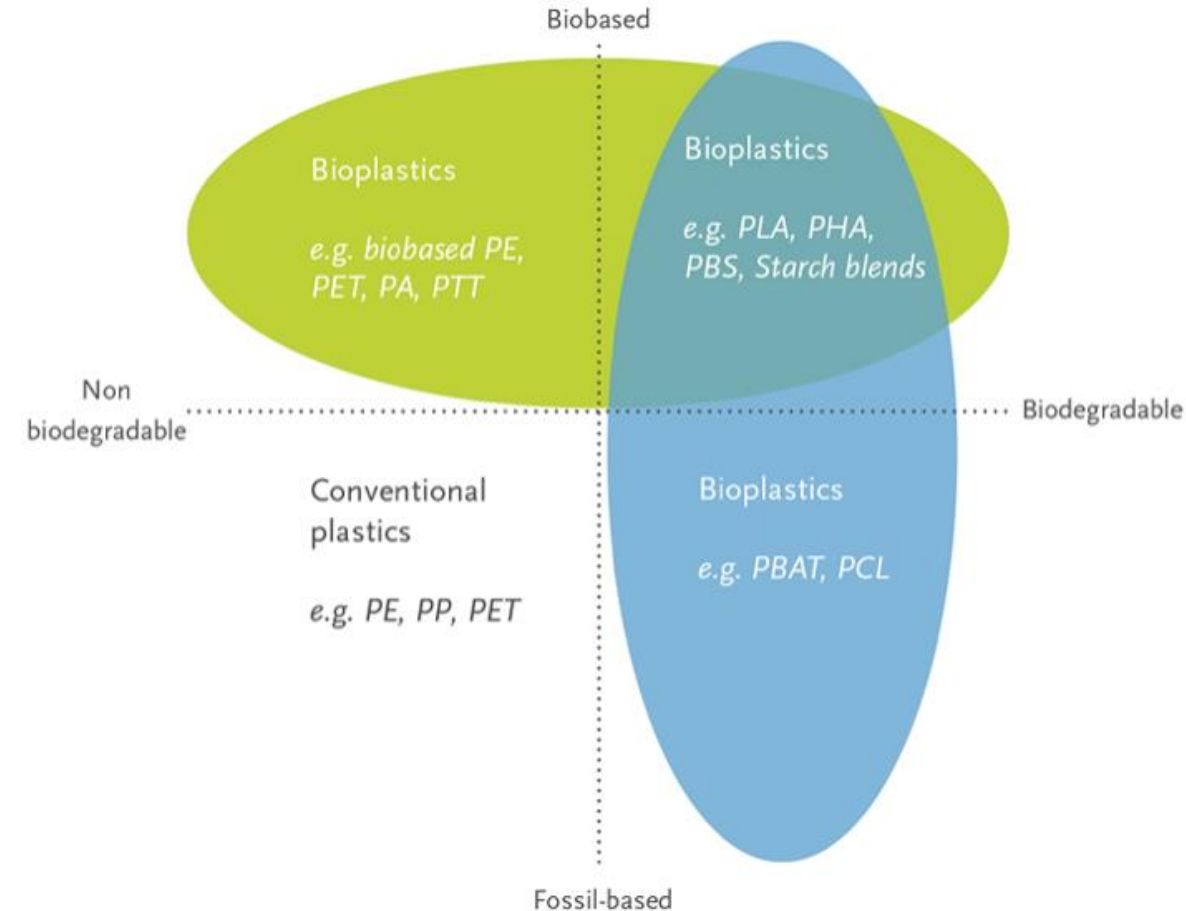


Sources: UNEP 2021, adapted from Jambeck et al. 2018; PlasticsEurope 2019; Geyer 2020.

Illustrated by GRID-Arendal

## ▶ What are bioplastics?

- ▶ Plastics that are **biobased**, **biodegradable** or **both**.
- ▶ There are three main groups:
  - **Bio-based/partially bio-based and non-biodegradable plastics** *e.g. bio-based PE, PP, or PET (so-called drop-ins) and bio-based technical performance polymers, such as PTT or TPC-ET.*
  - **Bio-based and biodegradable** *e.g. PLA and PHA or PBS.*
  - **Fossil resource-based and biodegradable** *e.g. PBAT.*



Source: European Bioplastics 2021

## Global production of bioplastics

- ▶ The production of bioplastics was **2.1 million metric tons** in 2018, which takes up **<1% of the total plastic market** (*Plastics Europe 2021*).
- ▶ This is set to increase to approximately **7.59 million tonnes in 2026** (*European bioplastics 2021*).
- ▶ Biodegradable PBAT (polybutylene adipate terephthalate), PBS (polybutylene succinate), and bio-based PAs (polyamides) are the main drivers of this growth.
- ▶ Currently, **biodegradable plastics** account for more than **64%** (over 1.5 million tonnes) of the global bioplastics production capacities.

Global production capacities of bioplastics

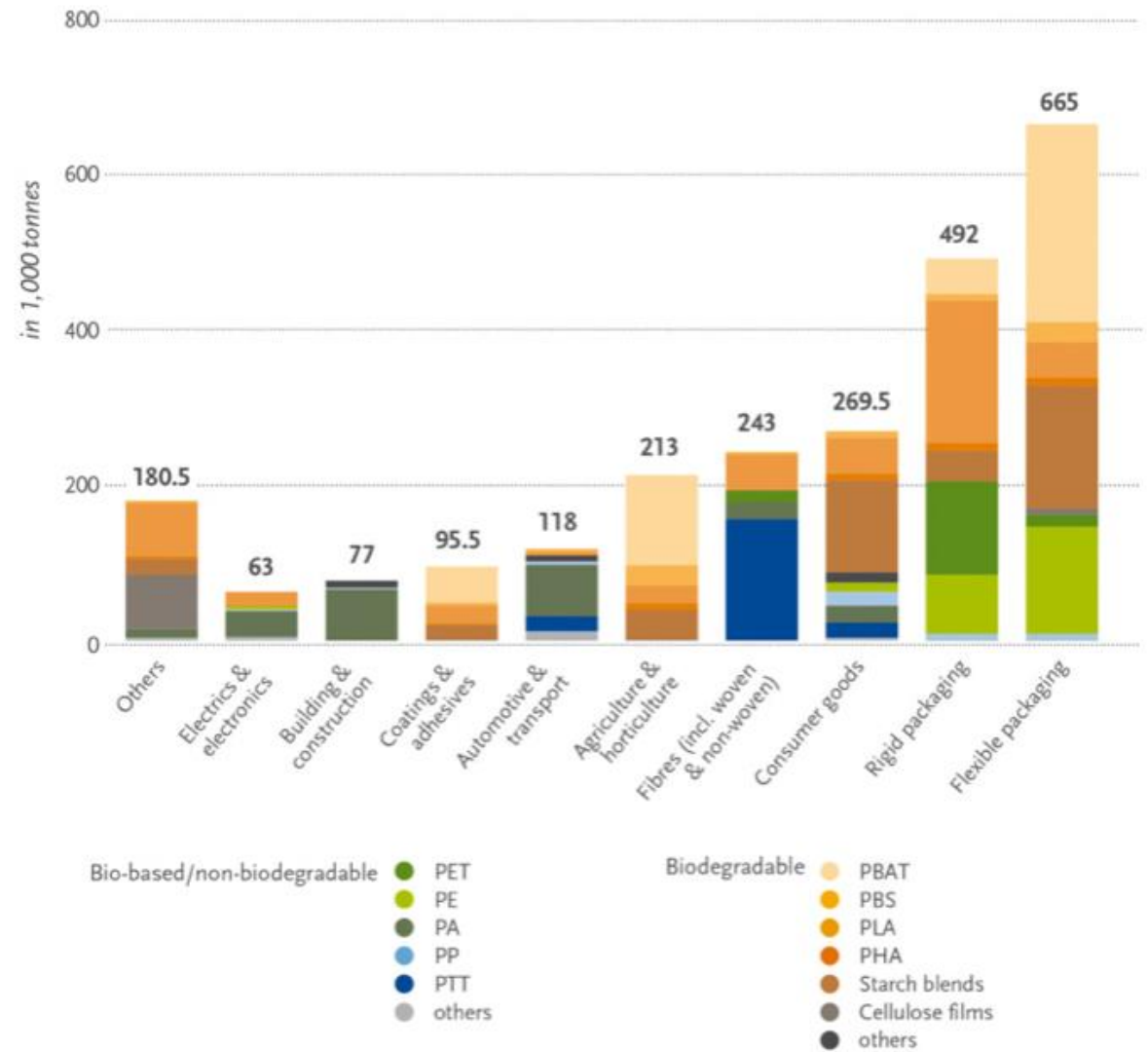


Source: *European Bioplastics 2021*

## Uses of bioplastics

- ▶ Bioplastics are used in an **increasing number of markets**, from packaging, catering products, consumer electronics, automotive, agriculture/horticulture, and toys to textiles and several other segments.
- ▶ **Packaging remains the largest market segment** for bioplastics with 48% (1.15 million tonnes) of the total bioplastics market in 2021.
- ▶ However, the portfolio of applications continues to diversify.
- ▶ Segments, such as **automotives & transport** or **building & construction**, remain on the rise with growing capacities of functional polymers.

Global production capacities of bioplastics 2021 (by market segment)



Source: European Bioplastics 2021

# The environmental consequences of plastics



## ▶ The environmental consequences are a global concern

- ▶ Plastic pollution can alter ecosystems, habitats and natural processes, as well as reducing their ability to adapt to climate change.
- ▶ This can directly affect millions of people's livelihoods, food production capabilities and social well-being (*UNEP n.d.*).
- ▶ Production relies on ever increasing use of fossil resources, contributing to climate change, and most plastic waste either ends up in landfill, is burned or leaks into the environment.



## Summary of environmental issues

Environmental issue	Significance
Fossil fuel use	Not significant (6% of oil, 4% of gas)
Production emissions: Climate change, acidification, smog (all driven by fossil fuel combustion)	Somewhat significant (4-6% of fossil greenhouse gases)
Production emissions: Human and eco-toxicity	Fairly significant
Plastic as environmental pollutant	Significant



## ▶ GHG emissions from the plastics industry are increasing

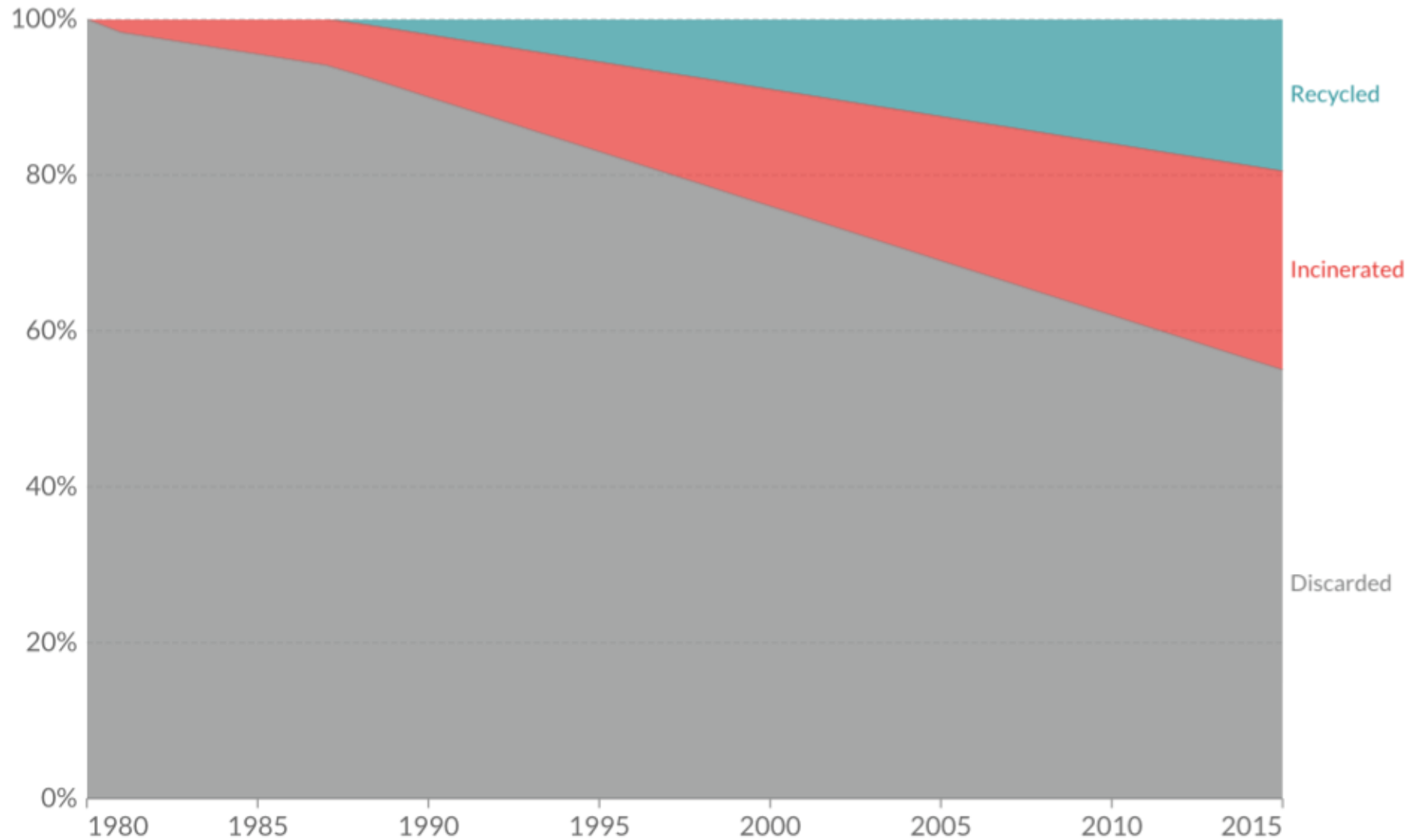
- ▶ A report by Enck and Vallette (2021) looked at how the **U.S. plastics industry** is contributing to **climate change**.
- ▶ It found that the industry is releasing at least **232 million tons of GHG each year**, the **equivalent of 116 average-sized coal-fired power plants**. This included:
  - **Hydrofracking of plastics feedstock** releases methane, a powerful climate change pollutant. By 2025, methane releases could reach 45 million tons each year, which is more GHG than was released by 22 average coal-fired power plants in 2020.
  - **Polymers and Additives Production** emits at least 14 million tons of GHG each year - equivalent to seven coal-fired power plants.
  - **Municipal Waste Incineration** of plastic waste emits at least 15 million tons of GHG each year - equivalent to at least seven coal-fired power plants.
- ▶ The industry is on track to **release more GHG emissions** than coal-powered electricity generating plants by 2030.

## ▶ The problem of plastic waste

- ▶ Despite providing significant benefits, current production methods, including extraction, use, and disposal of plastics, has many **drawbacks for human health and the environment.**
- ▶ The **linear economy of plastics** use means that large volumes are **discarded after use**, contributing to a growing **environmental catastrophe** and a huge **loss of precious resources.**
- ▶ Approximately **7 billion of the 9.2 billion tonnes** of plastic produced from 1950-2017 became **plastic waste**, ending up in landfills or dumped (*UNEP n.d.*).

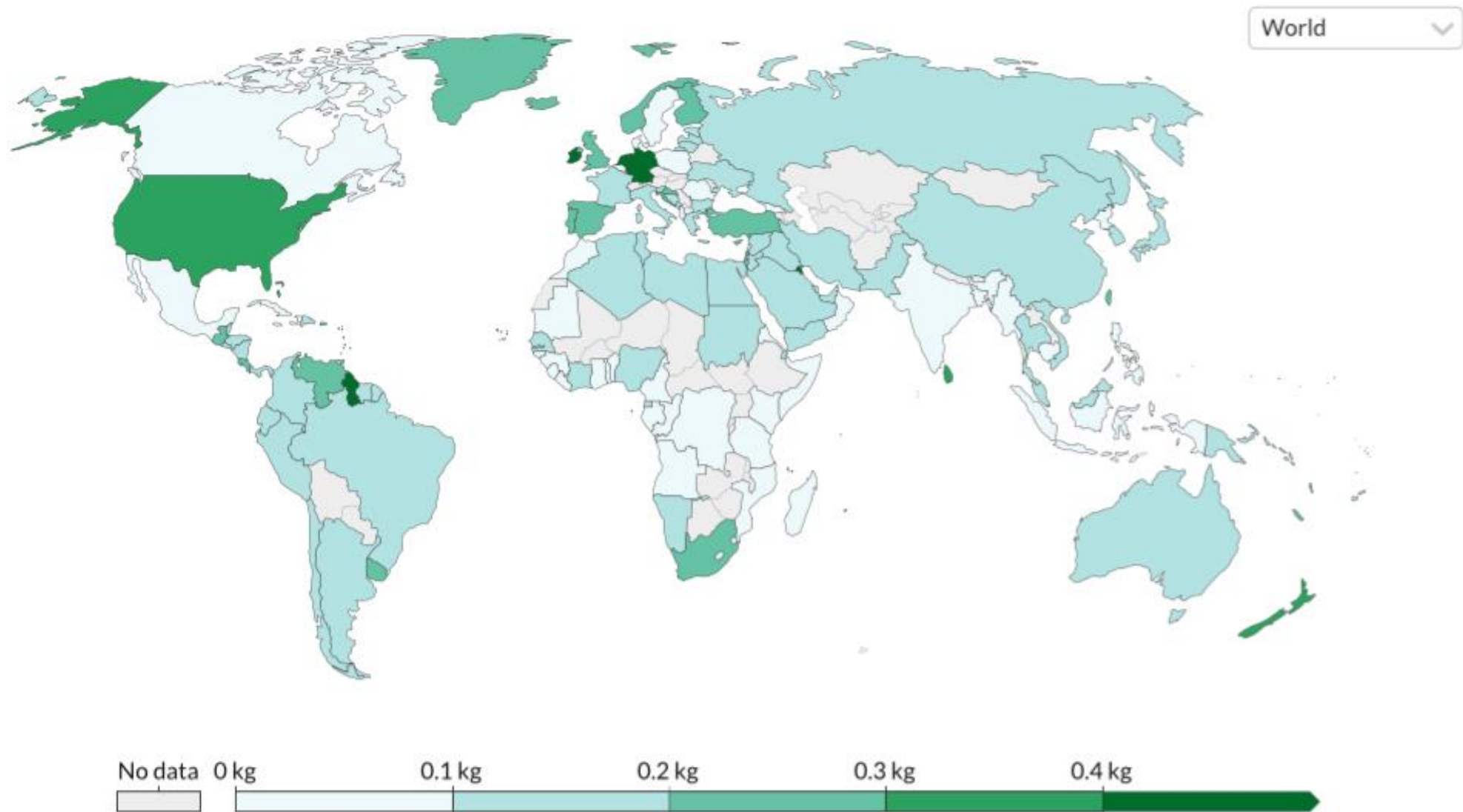
Every minute, the equivalent of one rubbish truck of plastic is dumped into our oceans  
(*UNEP n.d.*).

# Global plastic waste by disposal, 1980 to 2015



Source: Geyer et al. 2017

# Plastic waste generation per person, 2010



## ▶ Plastic waste is increasingly exported to developing countries

- ▶ Plastic waste generation is increasing in developing countries, due in part to **greater urbanization** and **higher economic growth**.
- ▶ In 2015, Asia was the **largest contributor** to global plastic waste, generating 82 million tonnes, while Latin America and Africa each produced 19 million tonnes and Oceania almost 1 million tonnes (*Lebreton and Andrady 2019*).
- ▶ Until China **banned the import of recyclable waste** (including plastics) in 2018, it accepted large amounts of plastic waste.
- ▶ Since the Chinese ban there has been an **increase in exports of plastic waste to emerging economies**.
- ▶ Environmental impacts are therefore being shifted to other countries, where the capacity to manage this waste in an environmentally sound manner may not be comparable (*GRID-Arendal 2019*).
- ▶ The **degree of risk** depends on conditions in the receiving region, including **environmental laws and regulations**, the **occupational health and safety** of workers and the **type of plastics** being processed.

Plastics  
exposures in  
the  
workplace



## ▶ Pure plastics

- ▶ Exposures to pure plastics in the workplace may have a limited impact on worker health because:
- They have low toxicity due to their insolubility in water
  - They have a large molecular weight and therefore are biochemically inert.



## ▶ Hazardous chemical exposures

- ▶ However, workers may be exposed to hazardous chemicals during **all stages of plastic's lifecycle**.
- ▶ This includes during the **extraction of fossil fuels** used to make plastics, the **production of plastics** and their **disposal**, either through recycling or incineration.
- ▶ Impacts on human health will vary depending on the substance type and route of exposure, either via **inhalation**, **ingestion** or **dermal contact**.



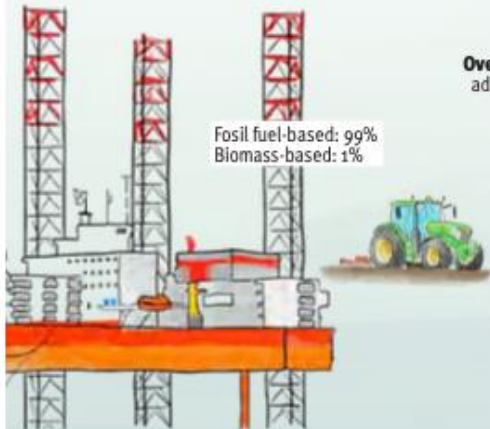


# The plastics lifecycle

## The plastics life cycle

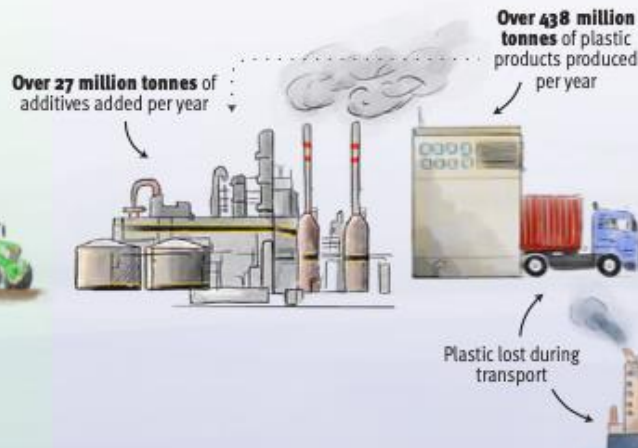
### 1. Extraction & conversion

**Key stakeholders:**  
Raw material producers  
Monomer producers  
Polymer producers



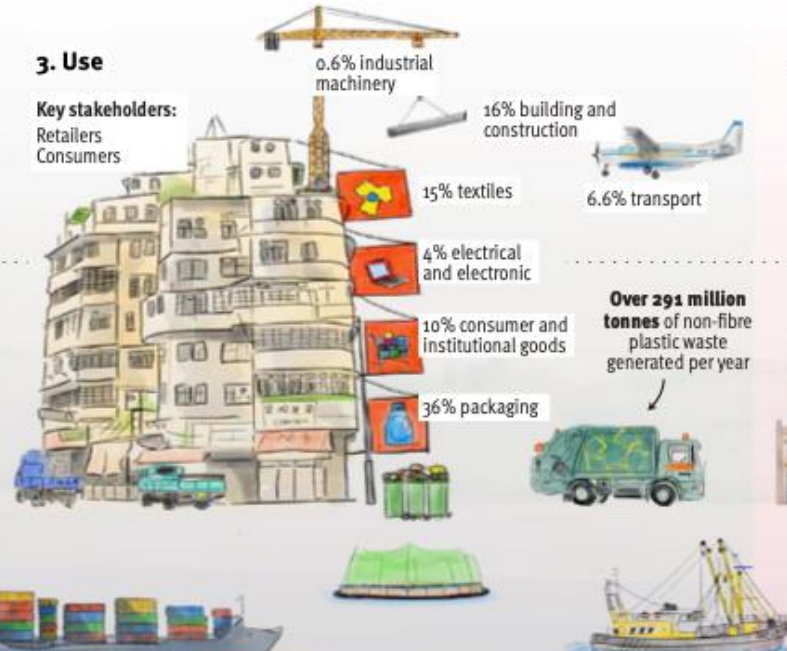
### 2. Manufactur-

**Key stakeholders:**  
Plastic processors  
Plastic producers  
Brands



### 3. Use

**Key stakeholders:**  
Retailers  
Consumers



### 4. End of life

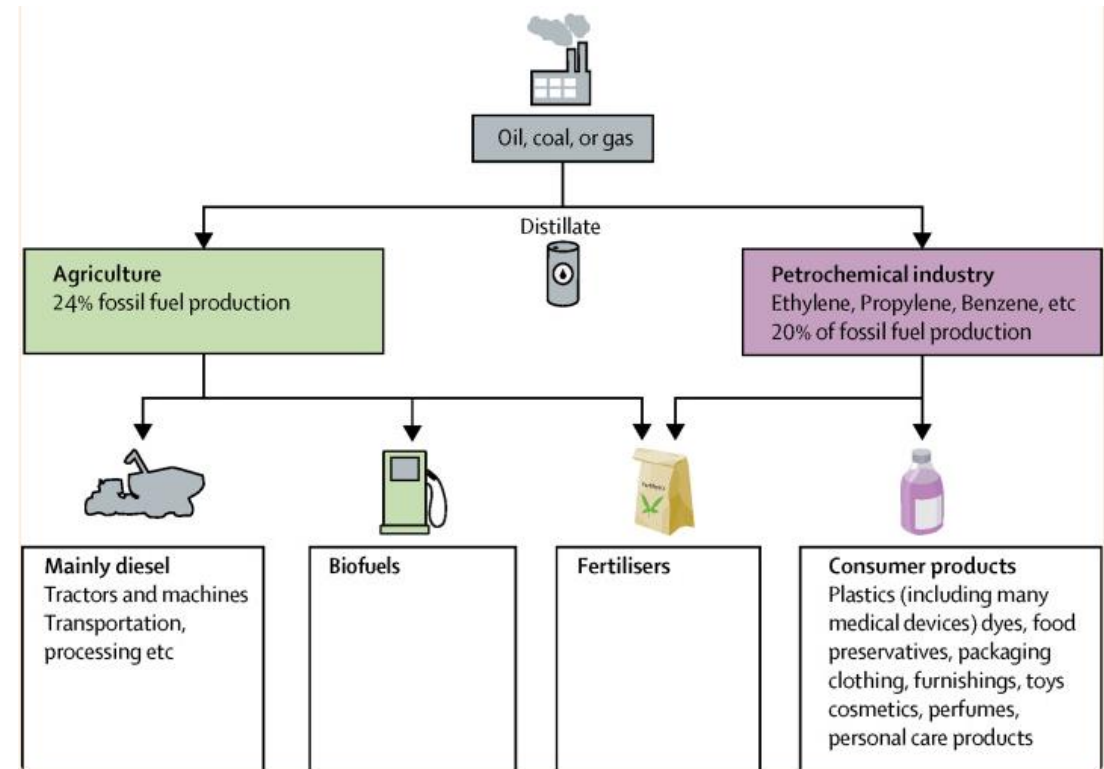
**Key stakeholders:**  
Formal waste sector  
Informal waste sector



Sources: UNEP (2018), UNEP (2019), EEA (2020), Geyer (2020). Illustration by Levi Westerveld / GRID-Arendal (2021). Research by Maria Tsakona.

## Extraction and transportation

- ▶ **99% of plastic comes from fossil fuels** (Ciel 2019).
- ▶ The extraction of oil and natural gas releases an array of **toxic substances** into the air and water, often in **significant volumes**.
- ▶ Workers involved in the oil and gas industry may be exposed to hazardous chemicals during the **extraction, transportation and processing** of oil and gas.



Source: Demeneix 2020

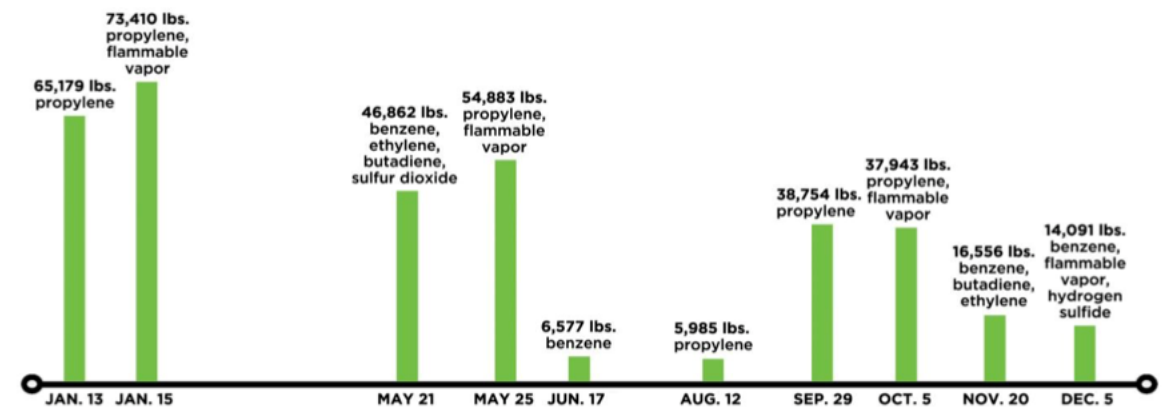
## Hazardous chemical exposures in the oil and gas industry

- ▶ **Respirable crystalline silica:** A risk for workers involved in hydraulic fracturing operations. Several job tasks were identified as having silica exposures exceeding OSHA and NIOSH exposure limits (*Witter et al. 2014*). Silica exposure has been linked to cancer and silicosis (*ILO 2021*).
- ▶ **Petroleum fumes** (e.g. benzene, butane and methane): A risk for workers near oil storage tanks. Known to cause cancers and damage to the nervous system, liver and kidneys (*ILO 2021*).
- ▶ **Hydrogen sulfide:** A widely recognized hazard in the oil and gas extraction industry, is naturally present in oil and gas deposits and may be produced as a by-product (*NIOSH 2018*). Exposures can occur during different operations e.g. well servicing and tank gauging (*Witter et al. 2014*). In addition to being highly flammable, exposed workers are at increased risk of respiratory symptoms (*Hessel et al. 1997*).
- ▶ **Diesel particulate matter (DPM):** Released from truck and construction equipment exhausts. DPM exposure has been linked to cardiovascular dysfunction, eye and nose irritation, nausea, asthma and neurodegenerative disease (*Donoghue 2004; Levesque et al. 2011*).
- ▶ Workers face the risk of **fire** and **explosion** due to ignition of flammable vapours or gases released from wells, trucks or equipment (*OSHA n.d.*).

## Case study: ExxonMobil refinery and chemical plant

- ▶ Events such as catastrophic industrial fires, explosions, and chemical releases are surprisingly common.
- ▶ For example, in 2013, an ExxonMobil refinery and chemical plant in Louisiana reported 76 incidences in a single year, an average of more than six per month (*White 2018*).
- ▶ The accidents resulted in the release of almost half a million pounds of chemicals and pollutants into the air.
- ▶ Among the top chemicals released were propylene, ethylene, and benzene, all of which are related to plastic production.

Major 2013 ExxonMobil Refinery and Chemical Plant Releases



In 2013 alone, ExxonMobil released more than 360,000 pounds of toxic substances from its Baton Rouge facilities, endangering the health and safety of facility workers and nearby residents.

Note: Pollution figures are from the ExxonMobil refinery and chemical plant facilities in Baton Rouge, Louisiana.

Source: *White 2018*

## ▶ Plastics production

- ▶ Workers in the plastics industry face **acute and chronic health risks** due to their increased exposure to hazardous chemicals (*Ciel 2019*).
- ▶ When **manufacturing** or **processing** plastics, often chemicals are used as a part of the process.
- ▶ Chemicals are either used to **make the plastic**, are **added to the product (chemical additives)** or are **produced as a by-product** as a result of the process eg in the form of plastic fume (*HSE n.d.*).
- ▶ Workers are exposed to these chemicals largely through the process of **heating materials** to make them more pliable for **creating plastic products** (*Ciel 2019*).
- ▶ Diseases resulting from these chemicals are **often diagnosed years after exposure** and are not reflected in global burden of disease measures.
- ▶ Workers may also be at risk of chemical exposures from **uncontrolled releases**, for example due to **major industrial accidents**.

## ▶ Plastics fume during plastic manufacturing (*HSE n.d.*)

- ▶ Plastics are usually processed as **pellets**, **granules** or **powders**.
- ▶ These include chemical additives such as **fillers**, **pigments**, **fire retardants** and **stabilisers**, depending upon requirements.
- ▶ The exact composition of any fume varies.
- ▶ Immediate effects may include **severe irritation** to the eyes, nose and lungs. In some cases, the effects can be **long-term** and **irreversible**.

Plastic	Constituents in fume
PVC	Hydrogen chloride
Fire-retarded ABS	Styrene, phenol, butadiene
Polypropylene	Formaldehyde, acrolein, acetone
Acetals	Formaldehyde
Polyethylene (low density)	Butane, other alkanes, alkenes
Polystyrene	Styrene, aldehydes

# The worst chemicals released during plastics production

Name	Use in plastics production	Occupational exposure	Health impacts
1,3-Butadiene	A chemical intermediate and as a monomer to make plastic.	Released into the air during production processes ( <i>EPA n.d.</i> ).	ST: Irritation of the eyes and throat, damage to the central nervous system, distorted blurred vision, vertigo, general tiredness, decreased blood pressure, headache, nausea, decreased pulse rate, and fainting. LT: Cardiovascular diseases and cancer ( <i>CDC n.d.</i> ).
Benzene	Chemical solvent to help form the monomers from which to make plastic resins, nylon, and synthetic fibres.	When used as a solvent and emitted from burning coal and oil ( <i>Weisel 2010</i> ).	ST: Headaches, tremors, drowsiness, and dizziness and death. LT: Wide-ranging health impacts from anaemia to leukaemia ( <i>Ciel 2019</i> ).
Styrene	The production of polystyrene plastic and resins.	Released into the air during production processes ( <i>Ciel 2019</i> ).	ST: Irritation of the lungs, eyes, nose, and skin. LT: Changes in vision, slowed reaction times, problems maintaining balance and even cancer ( <i>EPA n.d.</i> ).

Key: ST = Short-term exposure; LT = Long-term exposure

# The worst chemicals released during plastics production

Name	Use in plastics production	Occupational exposure	Health impacts
Toluene	To produce other chemicals, including benzene, and in the production of polymers such as polyethylene terephthalate (PET).	Released into the air during polymer production, through its use as a solvent, and during use of products containing toluene (Ciel 2019).	ST: Fatigue, weakness, memory loss, nausea, and appetite loss. LT: Irritation of the eyes or lungs, headaches and dizziness (Ciel 2019).
Ethane	Used for plastic production through its conversion into ethylene.	Ethylene production results in the emission of sulfur dioxide, nitrogen oxides, VOCs, particulate matter, lead, and carbon monoxide (Ciel 2019).	A variety including eye and throat irritation, nausea, headaches, and nose bleeds at low levels and more serious kidney, liver, and central nervous system damage at high levels. Also linked to allergies and respiratory problems such as asthma, and some are known or suspected carcinogens (Ciel 2019).
Propylene oxide	The creation of polyurethane plastic and other polyethers.	Released into the air during production processes (NIOSH 1989).	ST: Eye and respiratory tract irritation and is a mild central nervous system depressant. LT: Suspected carcinogen (EPA n.d.).

Key: ST = Short-term exposure; LT = Long-term exposure



## ▶ Case study: Styrene exposure among workers in the plastics industry in India

- ▶ Styrene is a clear colourless liquid that can be used to create polystyrene. It evaporates easily, so can be inhaled by workers.
- ▶ Styrene vapour can cause eye, skin and respiratory tract irritation, as well as neurological effects, such as memory dysfunction and difficulty concentrating (*HSE n.d.*).
- ▶ A study by Sati et al (2011) looked at styrene exposure in Indian plastic factory workers.
- ▶ Workers in the experimental group were exposed to styrene for at least 8 hours a day for more than a year.
- ▶ Assessment of lung functions showed a statistically significant reduction in most lung volumes, lung capacities (FVC, FEV1, VC, ERV, IRV, and IC) and flow rates in exposed groups compared to controls.
- ▶ Styrene exposure was also associated with increased levels of oxidative stress, which may have caused the lung damage.

## ▶ Women workers in plastics plants (*Dematteo 2012*)

- ▶ Workers in plastics production are exposed to numerous hazardous chemicals including **styrene, acrylonitrile, vinyl chloride, phthalates, bisphenol-A (BPA), brominated flame retardants** and **heavy metals**.
- ▶ They are exposed to **complex mixtures** of chemicals and combustion products, where combined effects may be greater than the sum of individual impacts.
- ▶ **Endocrine-disrupting chemicals (EDCs)** are ubiquitous in the plastics work environment and produce significant adverse effects at concentrations **thousands of times lower than the presumed safe levels** established by traditional toxicology.
- ▶ The chemicals are associated with **serious health hazards**, including **breast cancer** and **reproductive disorders**.
- ▶ This is of particular concern because the plastics industry has **a very high number of women workers**.
- ▶ Women are also at disproportionate risk due to the **types of jobs** they perform and their particular **biological vulnerabilities**.

## ▶ **Case study: Female breast cancer in workers in the plastics manufacturing industry in Canada**

- ▶ A case-control study by Brophy et al (2012) looked at breast cancer risk from exposure to carcinogens and endocrine disrupters in the plastics manufacturing industry.
- ▶ 1005 breast cancer cases referred by a regional cancer centre and 1146 randomly-selected community controls provided detailed data, including occupational and reproductive histories.
- ▶ The plastics manufacturing jobs involved primarily injection moulding, which entails taking molten mixtures of resins, monomer, multiple additives, and sometimes lamination films, and forming them into plastic pieces of defined dimensions and configuration.
- ▶ Emissions of vapours or mists from these hot processes can include plasticizers, ultraviolet-protectors, pigments, dyes, flame-retardants, un-reacted resin components and decomposition products. Further exposure came from skin contact in handling and performing finishing tasks.
- ▶ The study reported a five-fold increased risk of developing breast cancer in premenopausal women who work in the plastics industry.
- ▶ The strongest association was found with automotive plastics manufacturing.

## ▶ Plastic waste management

- ▶ Between 1950 and 2015, of all the plastic ever produced:
  - 60% entered the environment (either via landfill or marine and terrestrial litter)
  - 12% was incinerated
  - 9% was recovered for recycling (*Geyer et al. 2017*)



## ▶ Plastic waste incineration

- ▶ Emissions from open incineration of plastic waste can expose workers to hazardous chemicals.
- ▶ Air emissions associated with waste incineration include: **metals** (mercury, lead, and cadmium), **organics** (dioxins and furans), **acid gases** (sulphur dioxide and hydrogen chloride), **particulates** (dust and grit), **nitrogen oxides** and **carbon monoxide** (*Ciel 2019*).
- ▶ Workers may be exposed through:
  - **Inhalation** of contaminated air
  - **Direct contact** with contaminated soil and water
  - Through **ingestion** of contaminated food.
- ▶ Malfunctions also tend to occur when the facility **starts up** and **shuts down**, resulting in greater emissions compared to normal operating conditions (*National Research Council 2000*).

## ▶ Plastic waste incineration in developing countries

- ▶ The burning of plastic waste is a particular problem for waste workers in **developing countries**.
- ▶ Burning is often **uncontrolled** or in **low-technology incinerators**.
- ▶ Incomplete combustion may cause emissions of hazardous substances, such as acid gases and ash, which can contain **persistent organic pollutants (POPs)** (*UNEP 2021*).
- ▶ Newer incinerators apply **air pollution control technologies**, however filters do not prevent hazardous emissions, such as **ultra-fine particles** that are unregulated and particularly harmful to health (*Ostro et al. 2015*).

## ▶ Waste pickers

- ▶ Waste pickers are exposed to **serious health risks** throughout the waste processing cycle from waste collection to transportation, sorting, washing, heating and melting of plastic.
- ▶ It is estimated that waste pickers collect **58% of plastics**, thus **contributing significantly to supplying the value chain** and **avoiding plastic pollution** (*Cook and Velis 2021*).
- ▶ They face **chronic health risks**, such as respiratory disorders, due to prolonged and frequent exposure to faecal matter, medical waste and chemically hazardous substances leached in the waste, air emissions or by-products during the processing (*Flavia et al. 2013*).
- ▶ For the thousands of people, particularly in less developed countries or communities, that conduct plastic collection, recycling, and disposal under **poor conditions**, governments and local authorities should provide **proper health care** and **social protection** to ensure their occupational safety and health (*ILO & WIEGO 2017*).

## ▶ Waste picking facts and figures

- ▶ It is estimated that around **15-20 million people** work in the **informal recycling economy**.
- ▶ Around **4 million people** are in the **formal economy**.
- ▶ **3.3 to 5.6 million people** work in informal recycling in China.
- ▶ **Over a quarter million** people are in waste picking in Brazil.
- ▶ Waste pickers collect **50-100% of waste** in low-income countries.
- ▶ Waste pickers are often a **vulnerable demographic group**, including women, children, the elderly, the unemployed, or migrants.
- ▶ These are **large numbers of female waste pickers**, for example 50% in Vientiane in Laos, and 80% in Cusco, in Peru.
- ▶ Workers face **serious decent work deficits**, such as work-related safety and health hazards, discrimination, violence and harassment, low earnings, with no access to adequate social protection.



## ▶ Gender and plastic waste

- ▶ Women tend to be **under-represented in formal employment** in the waste management and recycling sector (*UNEP-COBSEA- SEI 2019*).
- ▶ A **traditional gendered division of labour exists** throughout the waste management and recycling value chain globally (*Aidis and Khaled 2019*).
- ▶ Women are represented in the greatest numbers at the **base of the recycling chain**, most often as informal waste pickers and sorters of recyclables, with **limited upward mobility**.
- ▶ “Men’s work” is typically associated with **heavy lifting** and thus **higher wages**.
- ▶ Women have less access to equipment, vehicles and waste than men; consequently, they are less able to access, collect and transport larger volumes and higher-value recyclables.
- ▶ Informal women waste collectors work **under challenging physical conditions**; they are threatened with danger to their safety and health, violence, harassment and exploitation (*WECEF 2017*).
- ▶ These women **lack secure employment, wages, legal protection** and any **recourse or representation** (*Aidis and Khaled 2019*).



International  
Labour  
Organization

# Chemical additives and microplastics



## ▶ Chemical additives

- ▶ Although plastics materials are themselves not harmful, chemical additives used to **improve product performance** are often **hazardous to human health**.
- ▶ Every plastic item contains additives that determine the **properties of the material** and influence the **cost of production** (*Stenmarck et al. 2017*).
- ▶ Additives have **numerous uses**, for example:
  - As stabilizers, fillers, plasticisers and colourants, as well as flame retardants and curing agents.
  - To inhibit photodegradation and to prevent microbial growth (*Ciel 2019*).
  - As initiators, catalysts and solvents during plastics manufacturing (*Galloway 2015*).
- ▶ **Harmful chemical additives** include phthalates, bisphenol A (BPA), lead, perfluorinated substances (PFAS) and polybrominated diphenyl ethers (PBDEs).

## Five types of plastic additives



### Functional

Includes, for example, stabilizers, antistatic agents, flame retardants, plasticizers, lubricants, slip agents, curing agents.



### Colourants

Substances such as dyes or pigments added to give colour to plastic. Some of them are added to give a bright transparent colour.



### Fillers

Added to change and improve physical properties of plastics. They can be minerals, metals, ceramics, bio-based, gases, liquids, or even other polymers.



### Reinforcement

Used to reinforce or improve tensile strength, flexural strength and stiffness of the material. For example: glass fibres, carbon fibres.



### NIAS

Non-intentionally added substances. They arrive in products from processes, such as reaction by-products or breakdown products.

UNEP (2021). Drowning in plastics – Marine Litter and Plastic Waste Vital Graphics.

Source: Hansen et al. (2013). Illustration by GRID-Arendal (2020).

## ▶ Many different chemicals are used as plastic additives

- ▶ The Plastics Additives Database lists **7,000 plastic additives** (*Flick 2004*).
- ▶ Identities and concentrations of additives are **generally not listed** on products.
- ▶ A randomly chosen plastic product generally contains around **20 additives** (*van Oers et al. 2011*).
- ▶ The most common additives are **fillers** (50% of the world additives market), followed by **plasticizers** (22%, of which more than 80% are phthalate plasticizers) (*van Oers et al. 2011*).
- ▶ The amount of additives contained in plastics varies depending on their function. For example, additives in polyvinyl chloride (PVC) can constitute up to **80% of the total volume** (*Hahladakis et al. 2018*).
- ▶ Specifically, **140 other chemicals or chemical groups** known to **adversely impact health** are actively added to plastics (*Endocrine Society and IPEN 2020*).

## ▶ Spotlight on endocrine-disrupting chemicals (EDCs)

- ▶ Plastics containing EDCs are used extensively in packaging, construction, flooring, food production and packaging, cookware, health care, children's toys, leisure goods, furniture, home electronics, textiles, automobiles and cosmetics (*Endocrine Society and IPEN 2020*).
- ▶ EDCs can act at very low doses to impair the functioning of the endocrine system.
- ▶ They can cause adverse health effects in an organism, its offspring or populations, such as changes in the morphology, physiology, growth, development, reproduction or life span.
- ▶ They have been linked to multiple reproductive disorders in men and women, as well as cancers, neurodevelopmental disorders and obesity.
- ▶ Known hazardous EDCs that leach from plastics include BPA, flame retardants, phthalates, PFAS, dioxins, UV-stabilizers and toxic metals, such as lead and cadmium.
- ▶ The plastics industries employ millions of workers globally, which use large quantities of chemicals that are known or suspected EDCs.
- ▶ As production volumes increase, the lifecycle of plastics containing EDCs represents a global challenge (*Chen et al. 2019*).

## ▶ How workers are exposed to chemical additives

- ▶ Plastics are composed of **chains of polymers**.
- ▶ Additives may be **weakly bound** to the polymers or **react** in the polymer matrix.
- ▶ The weakly bound additives can **leach out of the plastics** during **normal use**, when in landfills, or following **improper disposal** in the environment (*Wagner and Schlummer 2020*).
- ▶ Workers may therefore be exposed to plastics additives during the **entire life span of plastic products**, from manufacturing, consumer contact, recycling, waste management and disposal.
- ▶ Many additives are **highly hazardous** and therefore are a **significant concern** to occupational health (*Fucic et al. 2018; Montano 2014*).

## ▶ Focus on phthalates

- ▶ Phthalates are a **group of plasticizers** with a worldwide production volume of around **5.5 million tons per year** (*OECD 2018*).
- ▶ They are used to **soften plastics** and has a strong performance in terms of **durability** and **stability**.
- ▶ Phthalates are used widely in **polyvinyl chloride (PVC)**, which are used for products such as **packaging, construction materials** and **electrical wiring**.
- ▶ Phthalates are **EDCs** and have been associated with lower semen quality, neurodevelopment, risk of childhood asthma, low birthweight, endometriosis, decreased testosterone, ADHD, Type 2 diabetes, autism, obesity and breast/uterine cancer (*Eales et al. 2022*).
- ▶ There is only **limited data** regarding occupational exposure to phthalates. Since phthalates usually have a low vapor pressure, inhalation is often not the dominant route of uptake. **Oral** (e.g., hands-to-mouth transfer) and **dermal routes** can thus play an important role in total exposure (*Fréry 2020*).
- ▶ Many phthalates are **banned** and **restricted** in many countries, however use is still common in LMICs.



## ▶ Case study: Urinary phthalate metabolite concentrations among workers in selected industries

- ▶ A study by Hines et al (2009) looked at phthalate exposure across eight different industries, including phthalate manufacturing, PVC film, vehicle filters, PVC compounding, rubber hoses, rubber gaskets and rubber boots manufacturing.
- ▶ Occupational exposures to diethyl phthalate (DEP), di-*n*-butyl phthalate (DBP) and di(2-ethylhexyl) phthalate (DEHP) were assessed by analyzing for their metabolites in urine samples collected from workers at the end of their shifts.
- ▶ Evidence of occupational exposure to DEHP was strongest in polyvinyl chloride (PVC) film manufacturing, PVC compounding and rubber boot manufacturing where geometric mean (GM) end-shift concentrations of DEHP metabolites exceeded general population levels by 8-, 6- and 3-fold, respectively.
- ▶ Occupational exposure to DBP was most evident in rubber gasket, phthalate (raw material) and rubber hose manufacturing, with DBP metabolite concentrations exceeding general population levels by 26-, 25- and 10-fold, respectively.
- ▶ Concentrations of DEP and DMP metabolites in phthalate manufacturing exceeded general population levels by 4- and >1000-fold, respectively.
- ▶ The study suggested inhalation was a likely exposure route in most sectors. Workers with the highest DEP, DBP and DEHP exposures all worked on or near processes involving heating materials with large surface areas.

## ▶ Focus on Bisphenol A (BPA)

- ▶ BPA is utilized in the production of a variety of polymers such as **polycarbonate plastics** or **epoxy resins** and in the production of **thermal paper**.
- ▶ BPA is also an **EDC**. It has been linked to **breast cancer, prostate cancer, endometriosis, heart disease, obesity, diabetes** and **altered immune system functioning** (*Ciel 2019*).
- ▶ Limited studies exist regarding the health effects of occupational exposure to BPA.
- ▶ A literature review by Ribeiro et al. (2017) looked at BPA exposure in industries including epoxy resin production found that:
  - Occupationally exposed individuals have significantly **higher detected BPA levels** than environmentally exposed populations.
  - The detection rate of serum BPA **increases in relation to the time of exposure**.
  - Potential health effects correlated with detected BPA levels included male sexual dysfunction, endocrine disruption, alterations to epigenetic marks (DNA methylation) and effects on the offspring of parents exposed to BPA during pregnancy.

## ▶ Case study: Urinary bisphenol levels in plastic industry workers in Algeria

- ▶ Bisphenol A (BPA) is a known endocrine disruptor compound that is widely applied as a monomer base in polycarbonate plastics and as a binding agent in several epoxy resins.
- ▶ Plastic industry workers can have heavier and prolonged exposures to BPA.
- ▶ A study by Rebai et al. (2021) looked at 170 urine samples from a cross-sectional study of workers from a plastic industry located in north Constantine (Algeria).
- ▶ The majority of urine worker samples contained BPA (80.72% for total BPA and 36.47% for free BPA).
- ▶ Significant associations with BPA urinary levels were noted with age, occupational level of exposure and years of experience.
- ▶ Although workers possessed collective and personal protective equipment (gloves and masks), 73.53% of the participants studied did not use them daily.
- ▶ Moreover, 32.94% of workers stated that they have eaten in the work-place.

## ▶ Polybrominated diphenyl ethers (PBDEs)

- ▶ Polybrominated diphenyl ethers (PBDEs) are a group of **man-made organobromine compounds**.
- ▶ They have been used as **flame retardants** in a wide range of products including electrical and electronic equipment, textiles and foams.
- ▶ Studies in rats and mice show that PBDEs cause **neurotoxicity, developmental neurotoxicity, reproductive toxicity, thyroid toxicity, immunotoxicity, liver toxicity, pancreas effects (diabetes) and cancer (EPA 2017)**.
- ▶ Studies on animals and humans show that some PBDEs can act as **endocrine system disruptors** and tend to deposit in human adipose tissue (*EPA 2017*).
- ▶ The above hazardous properties of PBDEs have led to commercially supplied penta-, octa- and decaBDE, which contain a range of PBDEs, being classified as **persistent organic pollutants (POPs)** under the **Stockholm Convention on Persistent Organic Pollutants**.
- ▶ Workers may be exposed to PBDEs by **breathing contaminated air** or **swallowing contaminated dust**.
- ▶ Working in industries that make these chemicals or that make, repair, or recycle products containing these chemicals flame retardants can result in exposure (*CDC n.d.*).

## ▶ Case study: PBDE exposure in gymnastics studios in the USA

- ▶ Coaches spend long hours training gymnasts using polyurethane foam in the form of loose blocks, mats, and other padded equipment.
- ▶ Polyurethane foam can contain flame retardant additives such as PBDEs, to delay the spread of fires.
- ▶ A study by Ceballos et al. (2018) evaluated flame retardant exposure at the gymnastics studios 'before, during, and after' foam blocks in safety pits were replaced with foam blocks certified not to contain several flame retardants, including PBDEs.
- ▶ It found statistically higher levels of 9 out of 13 flame retardants, including PBDEs, on employees' hands after work than before, and this difference was reduced after the foam replacement.
- ▶ Windows in the gymnastics areas had higher levels of 3 of the 13 flame retardants than windows outside the gymnastics areas, suggesting that dust and vapor containing flame retardants became airborne.
- ▶ Mats and other padded equipment contained levels of bromine consistent with the amount of brominated flame retardants in foam samples analyzed in the laboratory.

## ▶ Microplastics

- ▶ Microplastics are **very small pieces** of plastic commonly defined as less than **5 millimetres (mm)** in size.
- ▶ They include **nanoplastics**, which are generally agreed to be **less than 1 micrometre (µm)** (*GESAMP 2016*).
- ▶ Microplastics exist in many forms, including **fragments**, **fibres** (referred to as “microfibres”), **spheres**, **films** and **pellets**.
- ▶ Now ubiquitous in the environment, they are present in food, water and air (*FAO 2017*).
- ▶ There are two types of microplastics (*Arthur et al. 2009*).
  - **Primary microplastics** are manufactured for the purpose of being added to (or used in the production of) other products, e.g. feedstock pellets and cosmetic microbeads.
  - **Secondary microplastics** are created by the fragmentation and degradation of macroplastics (plastic items greater than 5 mm in size) e.g. fibres from synthetic textiles and particles produced by tyre abrasion.

## Health impacts of microplastics

- ▶ It is estimated that people **consume** more than **50,000 plastic particles** per year – and many more if inhalation is considered (*UNEP 2021*).
- ▶ A recent study also found that **80% of people have microplastics in their blood** (*Leslie et al. 2022*).
- ▶ Human health may be impacted, as microplastics smaller than 20 µm can **penetrate organs** and smaller particles can **cross cell membranes** and **the blood–brain barrier** and can enter the **placenta** (*Campanale et al. 2020*).
- ▶ Microplastics have been linked to **oxidative stress**, **inflammatory lesions**, **metabolic disturbances**, **neurotoxicity** and **increased cancer risk** in humans, although limited research exists in this area (*Rahman et al. 2021*).



Source: Prata 2020

## ▶ Occupational exposure to microplastics

- ▶ Workers handling plastics at work may be exposed to increased levels of microplastics, depending on their role and industry, putting them at **increased risk of ill-health**.
- ▶ Workers may be exposed to microplastics in the workplace through **inhalation** via top-down and bottom-up mechanisms (*Murashov et al. 2020*):
  - **Top-down mechanisms** – Microplastics can be emitted during mechanical and environmental degradation of plastic goods which can lead to potential exposures among workers in the waste management and recycling operations (*Wohlleben et al. 2013*). Office workers may be exposed through degradation of carpets and other synthetic fibres (*Dris et al. 2017*), whilst those working in machining of polymer and plastic products may be exposed to microplastic dusts (*Ding et al. 2017*).
  - **Bottom-up mechanisms** – Microplastics can be emitted during high energy or high heat processes, such as laser cutting or high-speed drilling (*Walter et al 2015*). Workers in facilities with plastic processers and 3D printers could also be exposed from melting or fusing of plastics (*Stefaniak et al. 2018*).



## ▶ Health impacts of occupational exposure to microplastics

- ▶ As yet **no framework** exists to **assess the risks** of microplastics to human health (*Noventa et al 2021*).
- ▶ The **pathophysiological consequences** of acute and chronic occupational exposure to microplastics are **currently unclear**.
- ▶ There are also presently **no occupational exposure limits (OELs)** for microplastics and therefore workers may be **unknowingly exposed** to hazardous levels of microplastics which pose a **significant risk to their health**.



## ▶ Case study: Interstitial lung disease in nylon factory workers in Canada

- ▶ Flock is cut or pulverized fibre (synthetic or natural) of small diameter that produces a velvet-like coating when applied to adhesive-coated fabric or other material.
- ▶ Flocked fabric is increasingly popular, especially as an upholstery covering and as blankets.
- ▶ Synthetic materials used to make flock include nylon, rayon and polyester.
- ▶ Work-related interstitial lung disease was diagnosed in workers at five nylon flock facilities in three different states and a Canadian province (*Eschehbacher et al. 1999*).
- ▶ The National Institute for Occupational Safety and Health hosted a workshop at which consulting pulmonary pathologists reviewed lung tissue samples from all the cases for which lung biopsy material was available (15 of 20 cases known in January 1998).
- ▶ Pathologists reached consensus that the histopathological findings revealed a characteristic lesion—a lymphocytic bronchiolitis and peribronchiolitis with lymphoid hyperplasia represented by lymphoid aggregates.
- ▶ The clinical presentation for the cases generally included cough, dyspnoea, restrictive ventilatory defect with reduction in diffusing capacity, and interstitial markings on chest radiographs or scans.
- ▶ Six of the cases improved after removal from workplace exposure without medical treatment. Six others, who had recovered with medical treatment and removal from the workplace, had relapses in both symptoms and objective findings after attempting to return to nylon flock work.

## ▶ Environmental impact of microplastics

- ▶ Microplastics generated on **land** can make their way to the **oceans** via household drainage, wastewater systems, street drains, poorly managed waste disposal sites, run-off from agricultural soils or transport through the air.
- ▶ **Sea-based sources** include maritime activities such as fishing, shipping and aquaculture, however volumes released tend to be less than those from land-based sources.
- ▶ Larger plastics that have made their way into the environment can **slowly degrade** or **fragment** into smaller pieces and eventually into microplastics.
- ▶ The primary causes of this breakdown are **solar UV radiation** and **physical abrasion**, which make the plastic weak and brittle over time.
- ▶ Once in the environment, microplastics **do not biodegrade**.
- ▶ They **accumulate** in animals, including fish and shellfish, and are consequently also consumed as food by humans.



# Overview of priority actions



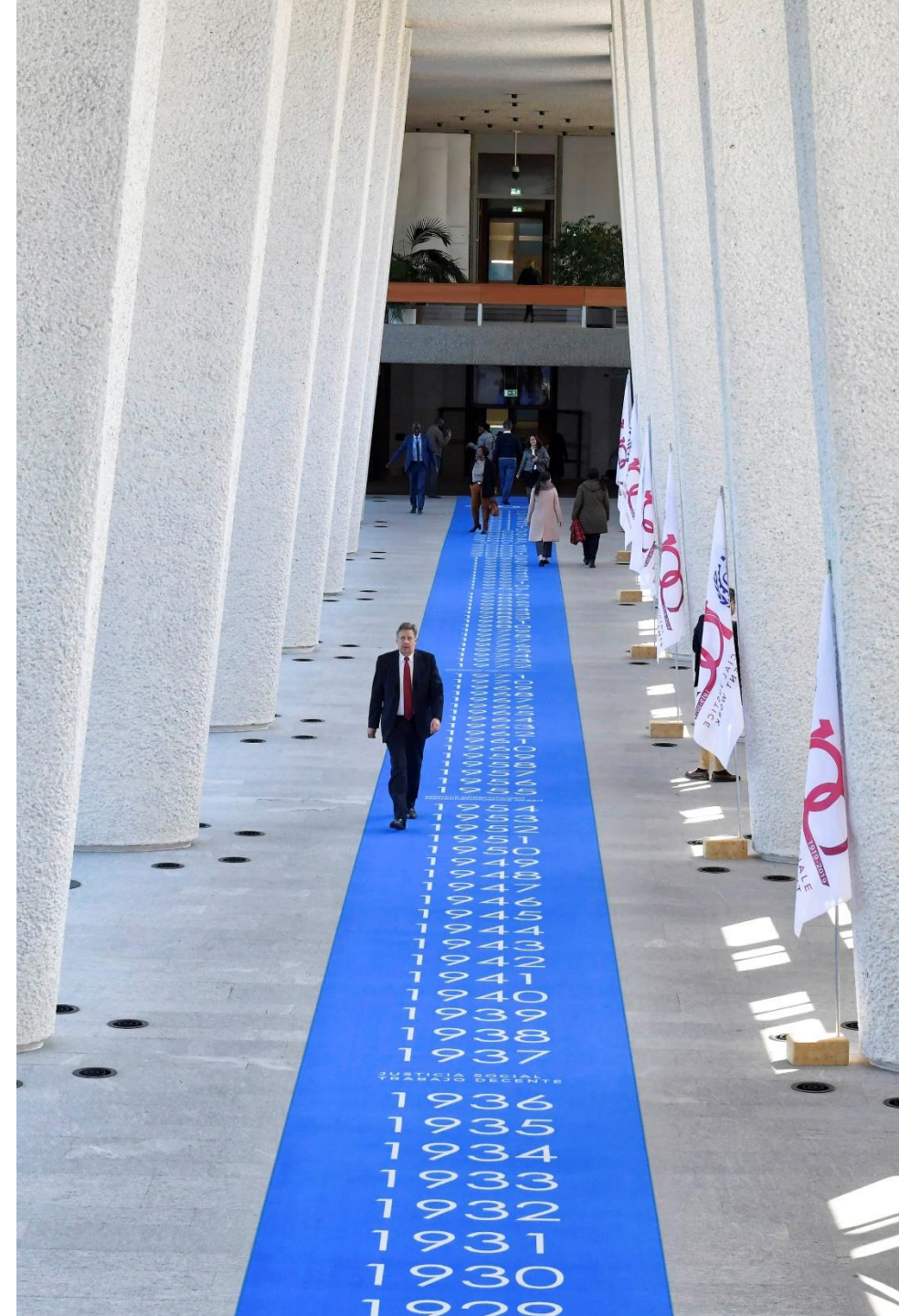
## ▶ An integrated approach is needed

### ▶ Plastics bring new risks to the health and safety of workers.

- ▶ National programmes on occupational safety and health (OSH) must now account for **changing world of work issues** such as plastics exposures in the workplace.
- ▶ An **integrated OSH systems approach** is needed at national and workplace levels, with plastics exposures considered at **all stages of occupational risk assessments**.
- ▶ Evidence must be matched to policy initiatives that consider the **new and known risks** associated with occupational plastics exposures, including plastics additives and microplastics.

## ▶ List of priority actions

- ▶ General approaches to reduce plastic consumption and production.
- ▶ Policy level actions, including ILO international labour standards.
- ▶ Other ILO green initiatives.
- ▶ Multilateral environmental agreements.
- ▶ Workplace level priority actions.
- ▶ Other recommendations





► **Measures to reduce  
plastics production  
and consumption**

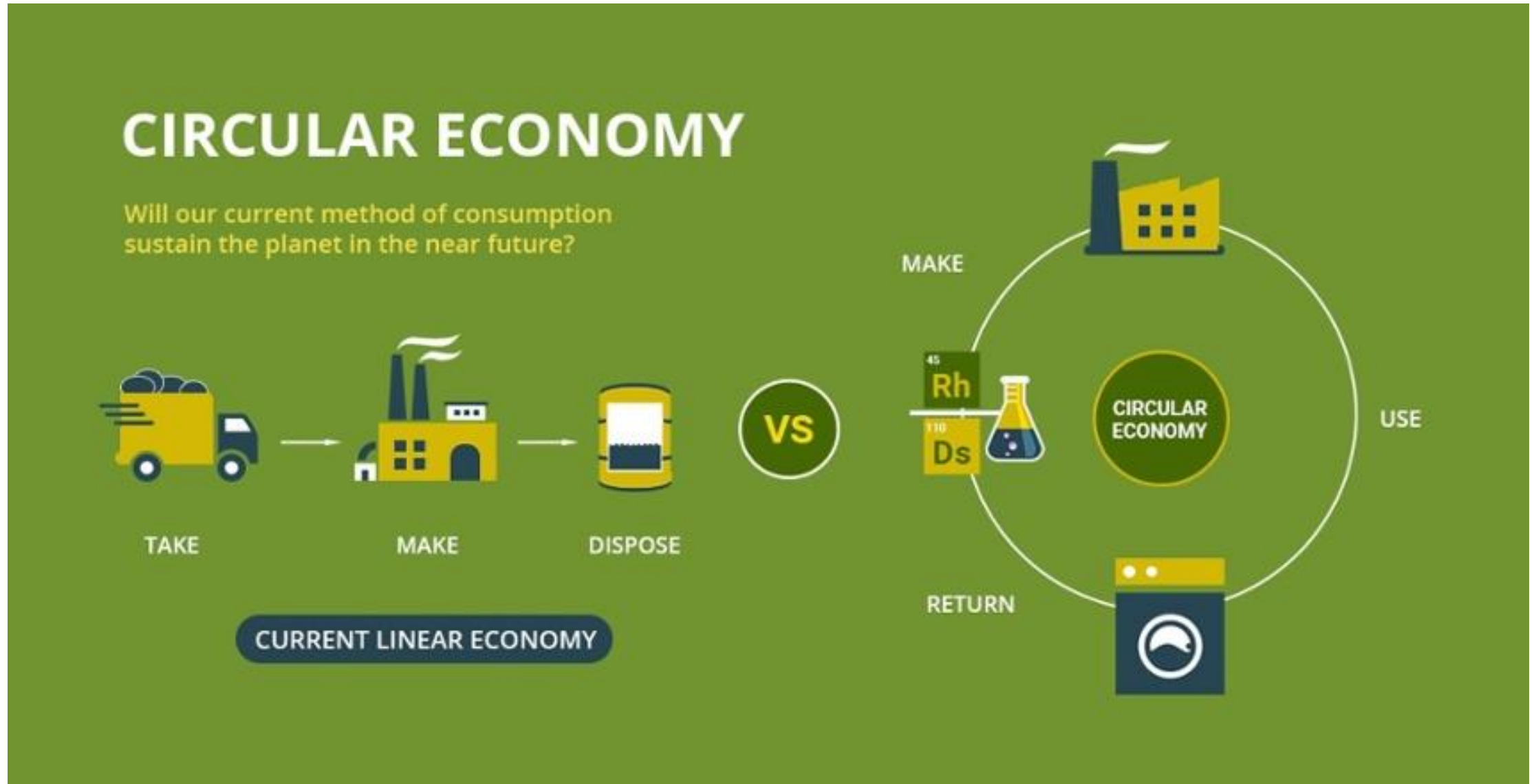
## ▶ A circular economic is the way forward

- ▶ The **circular economy** is an economic system in which materials are designed to be **used, not used up** (*Ellen MacArthur Foundation n.d.*).
- ▶ In contrast to the **'take-make-waste' linear model**, a circular economy is **regenerative** by design and aims to gradually **dissociate growth** from the **consumption of finite resources**.
- ▶ It aims to ensure **no materials are lost, no toxins are leaked**, and the **maximum use** is achieved from every process, material and component.
- ▶ A circular economy for plastics is important to **significantly reduce plastics use**, as well as ensuring that plastics which are used are **managed responsibly** throughout their lifecycle.
- ▶ By 2040, a circular economy for plastics has the potential to **reduce the annual volume of plastics entering our oceans by 80%** and **reduce greenhouse gas (GHG) emissions by 25%** (*Ellen MacArthur Foundation n.d.*).



# A comparison of linear and circular economies of plastic

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## ▶ In a circular economy for plastics (*PACE 2021*):

- ▶ **Problematic or unnecessary plastics are eliminated.**
  - 90% of floating marine debris is plastic. Eliminating problematic or unnecessary plastics, will benefit human health and biodiversity.
- ▶ **Material inputs for plastics are safe, recycled, or renewable.**
  - A shift away from plastics production using virgin materials will help reduce greenhouse gas emissions and dependence on finite fossil resources.
- ▶ **Plastics are reused more.**
  - Reuse models, such as refillable bottles or dispensing jars for dried goods, reduce the need for single-use plastics. Reusing plastics is positive for the environment, biodiversity, and human health.
- ▶ **Plastics are recycled or composted at end-of-use.**
  - Today, just 14% of plastic packaging is collected for recycling. In a circular economy, plastics that cannot be used or reused any longer should be collected, then recycled or composted.

## ▶ A circular economy can lead to reductions in greenhouse gases (GHG)

- ▶ Almost all plastics are made from **oil and natural gas feedstocks**.
- ▶ If they remain unchecked, **plastic-related GHG emissions** are projected to grow to **15% of the global carbon budget by 2050** (*Zeng and Suh 2019*).
- ▶ A combination of intensified application of the following mitigation strategies has the potential to curb growing GHG emissions from the plastic lifecycle (*Zeng and Suh 2019*):
  - **Bio-based plastics.** Fossil fuel-based plastics are gradually substituted by bio-based plastics until they are completely phased out by 2050.
  - **Renewable energy.** The energy mix of the plastics supply chain is gradually decarbonized and reaches 100% renewables (that is, wind power and biogas) by 2050.
  - **Recycling.** Recycling rates of end-of-life plastics gradually increase and reach 100% by 2050.
  - **Reducing growth in demand.** The current annual growth rate of global plastics demand (4%) is reduced to 2%.

## Cons exist for biodegradable plastics and bioplastics

- ▶ Similar problems exist with bio-based plastics made from renewable raw materials as with conventional plastics.
- ▶ Bio-based plastics can also contain **toxic additives** and contaminants, which although manufactured from plant-based polymers, are **not necessarily biodegradable**. They can fragment into **microplastics** and persist in the environment for long periods.
- ▶ One of the most important disadvantages of bioplastics is that they can **contaminate the recycling process** if they are not separated from conventional plastics.
- ▶ Mixing PET and PLA fragments during the recycling processes would create issues for the reprocessing unit, as these two materials have **different melting points** (*Alaerts et al. 2018*).
- ▶ The use of industrial compostable processes can be problematic for biodegradable bioplastics, which **may not fully degrade** and therefore can **contaminate the output** (*Heinrich Böll Foundation and Break Free from Plastic 2019*).

## More cons for biodegradable plastics and bioplastics

- ▶ There is some evidence that people may not feel the same **sense of responsibility** to properly dispose of “biodegradable” plastic, if they assume it will break down in the environment (*GESAMP 2015*).
- ▶ Discarded biodegradable bioplastic bags, like conventional plastic bags, **pose risks to aquatic life**.
- ▶ Bio-based plastics **do not always have a lower environmental impact** than conventional plastics in terms of GHG emissions and fossil fuel consumption.
- ▶ The production of biomass for bio-based plastics can **divert land use** from the **cultivation of food crops** or expand cultivation areas into sensitive habitats and environments.
- ▶ It is currently up to **twice as expensive** to produce bio-based than fossil-based plastics (*Emadian et al. 2017*).
- ▶ Compared to traditional plastics, renewable plastic materials are **less robust** and **less durable** (*Chen and Yan 2019*).

## Environmentally sound management of plastic waste in developing countries

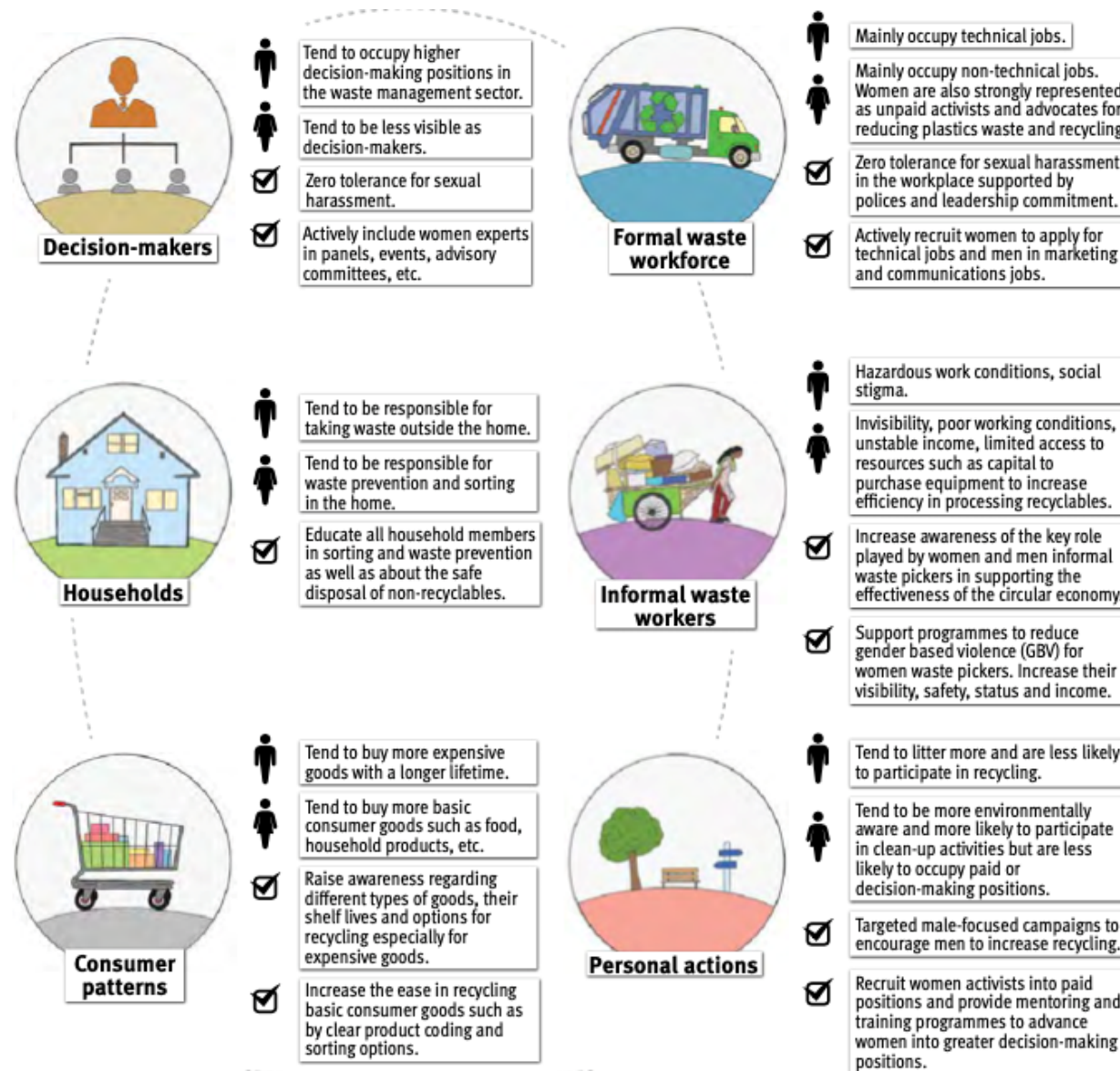
- ▶ Rapidly developing economies have been **overwhelmed** by increasing amounts of plastic waste.
- ▶ These countries are still heavily dependent on **conventional landfilling** and practices such as **open burning** and **dumps**.
- ▶ Improving waste management systems by making **basic infrastructure upgrades** to replace dumpsites could **reduce plastic leakage** into the environment.
- ▶ Countries need to **institute sustainable financing sources** for the development of waste management infrastructure and management (*Basel Convention 2021*).
- ▶ Integrating the informal sector into **formal waste management** strategies can play a key role in plastic waste management in developing countries.



## ▶ Environmentally sound management of plastic waste in developing countries

- ▶ Effective strategies to improve waste management include:
  - Implementing a combination of **environmental standards**.
  - Integrating the **informal waste sector** to create more organized structures (*UNEP 2020*).
  - Introducing **extended producer responsibility (EPR)** and **deposit-return schemes** (*UNEP 2018*).
- ▶ **Bans and fees on plastic products** have also contributed to preventing plastic waste generation in many developing countries.
- ▶ The absence of recycling programmes and limited access to recycling services are two of the main factors **influencing recycling behaviour**.
- ▶ To improve waste management, it is critical **to build trust within local communities** and **develop scalability** when implementing new technologies, businesses or products.

# Gender and plastic waste management







► **Policy level actions  
to protect workers**



## ▶ **International labour standards in a global regulatory framework on plastic pollution**

- ▶ **ILO international labour standards provide building blocks in the journey towards a global agreement on plastics.**
- ▶ Labour policies on skills and enterprise development, employment-intensive job creation and formalization of work, occupational safety and health, cooperatives and the social and solidarity economy are essential.
- ▶ The ILO has implemented successful projects around the world to support skills and enterprise development, employment creation and formalization of work in the plastic value chain, in partnership with industry as well as with employers' and workers' organizations.

## ▶ Ratify and implement ILO International Standards on OSH

- ▶ There are **no specific OSH standards** in the plastics industry.
- ▶ However governments, businesses and workers must adapt to and **manage the risks** of plastics exposures.
- ▶ Their ability to do so depends on **regulatory frameworks**, such as **international labour standards**.
- ▶ These standards **provide tools** for **managing the risks** associated with plastics exposures for workers and for ensuring **decent working conditions**.
- ▶ They provide the **legal foundation** for addressing **rising inequality** and the **increasing vulnerability of workers and enterprises** in the face of hazardous plastics, as well as for enhancing the adaptive capacity of communities.
- ▶ A national legal framework that **integrates environmental objectives** with **labour-related objectives** can go a long way towards ensuring that methods for dealing with plastics concerns are also employment friendly.

## ▶ Key ILO conventions related to OSH and chemical safety

The ILO has over 40 instruments related to OSH:

### ▶ Occupational safety and health conventions

- Promotional Framework for Occupational Safety and Health Convention (No. 187) and Recommendation (No. 197), 2006.
- Occupational Health Services Convention (No. 161), and Recommendation (No. 171), 1985.
- Occupational Safety and Health Convention (No. 155) and Recommendation (No. 164), 1981, and its Protocol of 2002.

### ▶ Chemical safety conventions

- Chemicals Convention (No. 170) and Recommendation (No. 177), 1990.
- Major Industrial Accidents Convention (No. 174) and Recommendation (No. 181), 1993.

## ▶ Implement a national OSH system

- ▶ A **strong national OSH system** is critical.
- ▶ **ILO instruments on OSH and chemical safety** should be ratified and implemented.
- ▶ **Plastics exposures** should be considered in all aspects of the system.
- ▶ Use a **management systems approach**, based on the general ILO principles of these OSH instruments, as well as the ILO Guidelines on occupational safety and health management systems (*ILO–OSH 2001*).
- ▶ This national policy framework should aim at the continuous harmonisation, integration and improvement of preventive and protective OSH measures, management systems and tools and capacity building, encompassing both the workplace and the environment.
- ▶ They should include **effective labour inspection services** provided with proper qualifications and training.

# Components of a national OSH system

## Should include:

- ▶ **Laws and regulations**, collective agreements where appropriate and any other relevant instruments on OSH.
- ▶ An **authority or body**, or authorities or bodies, responsible for OSH, designated in accordance with national law and practice.
- ▶ **Mechanisms for ensuring compliance** with national laws and regulations, including systems of inspection.
- ▶ Arrangements to promote, at the level of undertaking, **cooperation** between management, workers and their representatives, as an essential element of workplace-related prevention measures.

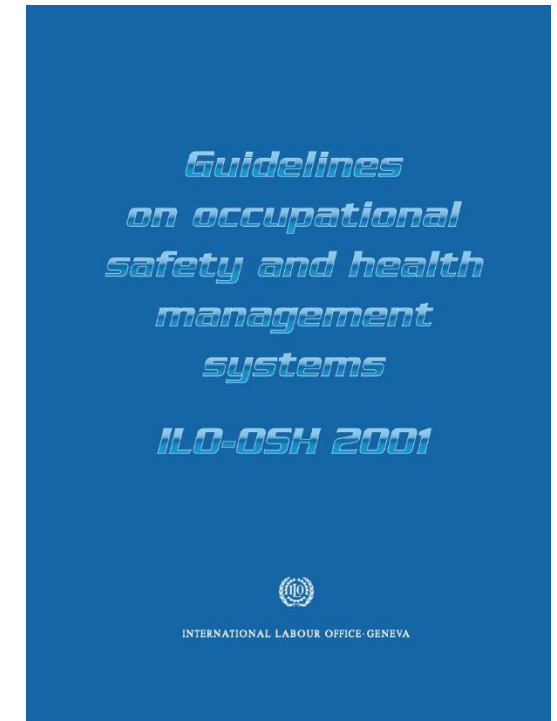
## Should also include, where appropriate

- ▶ A **national tripartite advisory body**, or bodies, addressing OSH issues.
- ▶ **Information and advisory services** on OSH measures.
- ▶ The provision of **OSH training**.
- ▶ **Occupational health services** in accordance with national law and practice.
- ▶ **Research** on OSH.
- ▶ A mechanism for the **collection and analysis of data** on occupational injuries and diseases, taking into account relevant ILO instruments.
- ▶ Provisions for collaboration with **relevant insurance or social security schemes** covering occupational injuries and diseases.
- ▶ **Support mechanisms** for a progressive improvement of OSH in micro-enterprises, small and medium-sized enterprises and the informal economy.

## ► Technical guidelines: OSH Management Systems Guidelines, 2001

### Non-binding guidance tool on the establishment of efficient OSH management systems.

- Ensure the continual improvement of the working environment and of preventative measures on OSH.
- Guidelines can be applied nationally and organizationally:
  - **Nationally:** provide for the establishment of a national framework for OSH management systems, preferably supported by national laws and regulations.
  - **Organizational:** encourage the integration of OSH management system elements as an important component of overall policy and management arrangements.
- Guidelines establish a hierarchy of controls which structures all OSH control measures in decreasing order of effectiveness.



# ▶ Globally Harmonized System of Classification and Labelling of Chemicals (GHS)

**Internationally agreed standard set up to create an internationally harmonized approach to classification and labelling of chemicals**

- ▶ Designed to cover all chemicals, including mixtures.
- ▶ Developed to inform and protect people involved in chemical production, handling, transport, use and disposal.
- ▶ Not legally binding, however implemented in 72 UN member states
  - Standardized hazard testing criteria
  - Universal warning pictograms
  - Harmonized SDS, which provide users of chemicals with hazard information





## ▶ ILO chemicals control toolkit

**Online scheme for Workplace Chemicals Control Kit designed for SMEs in developing countries.**

- ▶ Generic risk assessment based on GHS and task guidance sheets.
- ▶ Aim is to provide simple and practical means to prevent/reduce risks of chemicals.
- ▶ Toolkit Operation:
  - Hazard classification
  - Scale of use (amount of chemical used)
  - Ability for chemicals to become airborne
  - Finding the control approach
  - Finding the task-specific control guidance sheet(s)

## Occupational exposure limits (OELs)

### Develop, update and harmonize evidence-based OELs

- ▶ OELs exist for some of the most common hazardous chemicals associated with plastics (e.g. styrene), however these are not standardized and many chemicals are missing.
- ▶ A **priority system** for chemical OELs related to plastics should be created, focusing on those that do not exist or need to be updated.
- ▶ **Harmonised international guidelines** for chemical OELs should be produced and implemented.
- ▶ OELs for **microplastics** specifically should also be produced.

The workplace exposure limit (WEL) for styrene is currently 100 parts per million (ppm) averaged over an 8-hour day. There is also a short-term exposure limit (STEL), currently 250 ppm averaged over a 15-minute period (HSE n.d.).



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# IL0 environmental initiatives



## ▶ The ILO's Green Jobs Programme



- ▶ Works towards an **environmentally sustainable social and economic development**.
- ▶ Promotes worldwide the **creation of green jobs** as a way of **generating decent employment and income opportunities** with a **reduced environmental impact** and an increased ability to cope with the **challenges of climate change and scarce resources**.
- ▶ Green jobs are **decent jobs** in any economic sector which contribute to **preserving, restoring and enhancing environmental quality**.
- ▶ The programme follows two main strategies:
  - It addresses the employment and social dimension of environmental policies to ensure decent work to present and future generations.
  - It mainstreams environmental concerns into the world of work to change consumption and production patterns.
- ▶ The Green Jobs Programme has progressively assisted over 30 countries by building relevant ILO expertise and tools in dedicated areas of work.

## Components of the ILO's Green Jobs Programme

- ▶ **Diagnostics and prioritization** by identifying economic sectors with high potential for green job creation through national green jobs assessments.
- ▶ **Pilot projects** whereby tools for sectoral and thematic approaches are developed and tested such as green entrepreneurship, the greening of enterprises and local development of infrastructure.
- ▶ **Policy advice** for the formulation and implementation of effective national or sectoral policies that create green jobs, foster social inclusion and improve sustainability;
- ▶ **Knowledge sharing** so that others can learn from best practices and country experiences.

## Green Entrepreneurship

Kenya



“I noticed that there was a lot of plastic waste in Nairobi and thought that this was a business opportunity that could be developed. Today my company recycles plastic waste from dump sites and converts it into durable and weather-resistant products that are viable substitutes for wood in the building and construction sector.”

**Lorna Rutto**, *Eco Post Recycling Company*

ILO Youth Entrepreneurship Facility in Kenya,  
Uganda and Tanzania

## ▶ *ILO Guidelines for a Just Transition (2015)*

- ▶ Developed by the ILO through **tripartite discussion**.
- ▶ Can be used to ensure that **no workers are left behind** during the transition to a green economy, and that the transition also **strengthens decent work**.
- ▶ Offers a portfolio of policy options for addressing the issues associated with the **greening of the economy and the workplace** and with the transition towards sustainable development.
- ▶ Encourages governments to develop national policies and plans for mitigation of, and adaptation to, climate change, as well as for disaster preparedness,

- ▶ **User's manual to the ILO's Guidelines for a just transition towards environmentally sustainable economies and societies for all**



## ▶ OSH and Fundamental Principles and Rights at Work (FPRW)

- ▶ An amendment to the **ILO Declaration on Fundamental Principles and Rights at Work**, to include OSH, will be discussed during the 110th session of the International Labour Conference in June 2022.
- ▶ If adopted, the proposed amendment would indicate that all ILO Member States would have an **obligation to respect and promote safe and healthy working conditions** in the same manner and with the same level of commitment as the four principles currently covered by the ILO Declaration on Fundamental Principles and Rights at Work.
- ▶ The sound management of hazardous chemicals in the workplace is an essential component of any OSH strategy.

## ▶ Addressing how plastics are recovered will greatly enhance opportunities for decent work

- ▶ Aside from huge environmental benefits, a circular economy will open **new opportunities for decent work**.
- ▶ The ILO estimates that a shift to carbon-neutral and circular economies could generate **an additional 100 million jobs by 2030** (*ILO 2019*).
- ▶ A sustained **5% annual increase in recycling rates** for plastics, glass, wood pulp, metals and minerals, can generate **around 6 million additional jobs** across the world (*ILO 2018*).
- ▶ However, handling of plastic waste remains largely part of the **informal economy** in many LMIC, where workers face hazardous work conditions, discrimination, low earnings and long working hours.
- ▶ Addressing these gaps will greatly **enhance opportunities for decent work**.
- ▶ ILO's constituents – governments and employers' and workers' organizations – through **social dialogue**, have an important role to play to support a just transition.
- ▶ The green transition could create millions of jobs, but would require **major investments in reskilling** (*ILO 2019*).



## ▶ Two approaches to formalize & integrate waste pickers

- ▶ **The social and solidarity economy (SSE)** is *“a concept designating enterprises and organizations, in particular cooperatives, mutual benefit societies, associations, foundations and social enterprises, which have the specific feature of producing goods, services and knowledge while pursuing both economic and social aims and fostering solidarity”*.
- ▶ By forming or joining SSE organizations, waste pickers can:
  - **Pool resources** and jointly provide waste management services in public schemes.
  - **Strengthen collective voice** and representation of waste pickers in policy-making processes.
  - Improve **occupational safety and health**.
  - Have access to services and **social protection**.
  - Have access to **training** and **capacity building opportunities**.
- ▶ **A cooperative** is *“an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise”*.

## ▶ Case study: Inclusion in public schemes - Union and cooperative alliance – SWaCH, Pune, India

- ▶ The Solid Waste Collection and Handling (SWaCH) Cooperative Society was formed in 2008 as a public-private partnership to tackle the growing problem of solid waste management (SWM) in the city of Pune, India.
- ▶ It is a workers' Cooperative run by informal waste workers, which receives infrastructure and policy support from the Pune Municipal Corporation.
- ▶ The SWaCH Cooperative has evolved organically to be a critical actor in Pune's SWM system.
- ▶ It achieved this through awareness-raising exercises, demonstrations, and grassroots mobilisation around waste worker rights and SWM, and by instituting a democratic governance process involving all its 3,500+ waste workers.
- ▶ It has attained significant success in improving the SWM system in Pune, while also uplifting and protecting the livelihoods of its 3500+ informal waste worker members.
- ▶ Due to the SWaCH Cooperative's initiatives, today, 60 MT of waste is diverted away from landfills per day, with 80-85% of the waste generated in the city being recycled/processed, resulting in annual GHG emission savings of approximately 50,000 tonnes of CO<sub>2</sub>.

## ▶ **Case study: Access to services and social protection – MTE, Buenos Aires, Argentina**

- ▶ MTE, Movimiento de Trabajadores Excluidos, is a cooperative of over 3000 waste pickers in Buenos Aires.
- ▶ Members have a contract with the city government to provide waste collection services.
- ▶ Under the contract the city provides transport facility and monthly incentives.
- ▶ The members earn income from the monthly incentives and sales of the recyclables.
- ▶ The coop also set up a childcare centre for 160 children of waste pickers, with the support from both local and national governments.



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# Multilateral environmental agreements



## ▶ A new global treaty on plastics pollution

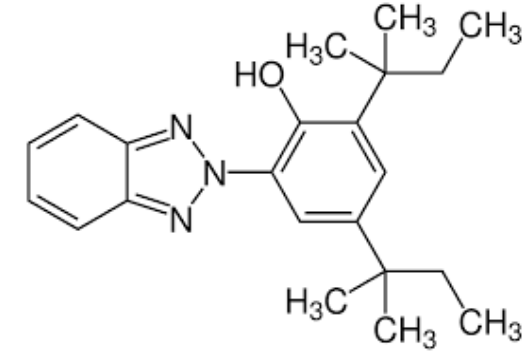
- ▶ A UN Environment Assembly resolution was passed on 2nd March 2022 entitled ‘End plastic pollution: Towards an international legally binding instrument’. The aim is to negotiate a treaty by the end of 2024.
- ▶ The resolution:
  - Noted with concern that the high and rapidly increasing levels of plastic pollution represent a serious environmental problem at a global scale, negatively impacting the environmental, social and economic dimensions of sustainable development.
  - Recognized that plastic pollution includes microplastics.
  - Stressed the urgent need to strengthen the science-policy interface at all levels.
  - Recognized the wide range of approaches, sustainable alternatives and technologies to address the full life-cycle of plastics further highlighting the need for enhanced international collaboration to facilitate access to technology, capacity building and scientific and technical cooperation and underlining that there is no single approach.
  - Recognized the significant contribution made by workers under informal and cooperative settings to collecting, sorting and recycling plastics in many countries.
  - Decided that the intergovernmental negotiating committee is to develop an international legally binding instrument on plastic pollution, based on a comprehensive approach that addresses the full lifecycle of plastic.

CONVENTION ON PLASTIC POLLUTION			
PILLAR 1 MONITORING AND REPORTING	PILLAR 2 PLASTIC POLLUTION PREVENTION	PILLAR 3 COORDINATION	PILLAR 4 TECHNICAL AND FINANCIAL SUPPORT
Monitoring and reporting on the state of the environment and implementation	Measures to reduce plastic pollution and promote a safe circular economy for plastics	Coordination with other international and regional instruments on relevant topics	Technical support to policymakers and financial support to developing countries
<p><b>Harmonisation</b></p> <ul style="list-style-type: none"> <li>• Definitions</li> <li>• Methodologies (monitoring, reporting)</li> <li>• Standardised formats</li> </ul> <p><b>Environmental monitoring</b></p> <ul style="list-style-type: none"> <li>• Baselines (seafloor, seawater, shoreline, biota, freshwater, soils)</li> <li>• Indicator species</li> <li>• Evolution of plastic pollution in marine and other environments</li> </ul> <p><b>National data reporting</b></p> <ul style="list-style-type: none"> <li>• National inventories and sources:               <ul style="list-style-type: none"> <li>- virgin plastic production and use</li> <li>- recycled plastic production and use</li> <li>- plastic-waste management</li> <li>- plastic-waste trade</li> <li>- land-based sources</li> <li>- sea-based sources</li> <li>- microplastics</li> </ul> </li> <li>• Evolution of circular economy and leakage</li> </ul> <p><b>Reporting on national action</b></p> <ul style="list-style-type: none"> <li>• Submission of national action plans</li> <li>• Periodic review and update</li> </ul> <p><b>Periodic comprehensive assessments</b></p> <ul style="list-style-type: none"> <li>• Progress toward global objectives</li> <li>• Scientific and socio-economic reviews</li> </ul>	<p><b>Global objectives</b></p> <ul style="list-style-type: none"> <li>• Long-term elimination of discharges</li> <li>• Safe circular economy for plastics</li> </ul> <p><b>National action plans</b></p> <ul style="list-style-type: none"> <li>• Policies and legislation:               <ul style="list-style-type: none"> <li>- targets and market restrictions</li> <li>- waste prevention and management</li> <li>- recycling and secondary markets</li> </ul> </li> <li>• Sustainable financing mechanisms</li> <li>• Infrastructure investments</li> <li>• International and regional commitments</li> </ul> <p><b>Microplastics</b></p> <ul style="list-style-type: none"> <li>• Intentionally added (e.g. microbeads, fertilisers)</li> <li>• Wear and tear (e.g. tyres, textiles)</li> <li>• Mismanagement (e.g. pellets)</li> </ul> <p><b>Standardisation</b></p> <ul style="list-style-type: none"> <li>• Labelling</li> <li>• Product design and additive restrictions</li> <li>• Certification schemes</li> <li>• Voluntary industry standards</li> </ul> <p><b>Virgin plastic production and use</b></p> <ul style="list-style-type: none"> <li>• Controls and quality standards</li> </ul> <p><b>Remediation and legacy pollution</b></p> <ul style="list-style-type: none"> <li>• Protocols and guidelines</li> </ul>	<p><b>Sea-based sources (including fishing gear)</b></p> <ul style="list-style-type: none"> <li>• International Maritime Organization (IMO)</li> <li>• Food and Agricultural Organization (FAO)</li> </ul> <p><b>Plastic waste trade</b></p> <ul style="list-style-type: none"> <li>• Basel Convention</li> <li>• Organisation for Economic Co-operation and Development (OECD) and regional instruments</li> </ul> <p><b>Chemicals and additives</b></p> <ul style="list-style-type: none"> <li>• Stockholm Convention</li> <li>• Strategic Approach to Integrated Chemical Management (SAICM)</li> </ul> <p><b>Biodiversity</b></p> <ul style="list-style-type: none"> <li>• Convention on Biological Diversity (CBD)</li> <li>• Convention on Migratory Species (CMS)</li> <li>• International Whaling Commission (IWC)</li> </ul> <p><b>Climate change</b></p> <ul style="list-style-type: none"> <li>• United Nations Framework Convention on Climate Change (UNFCCC)</li> <li>• Intergovernmental Panel on Climate Change (IPCC)</li> </ul> <p><b>Agriculture</b></p> <ul style="list-style-type: none"> <li>• Food and Agricultural Organization (FAO)</li> </ul> <p><b>Cross-regional knowledge exchange</b></p> <ul style="list-style-type: none"> <li>• Regional seas conventions and programmes</li> <li>• Regional fisheries management organisations</li> </ul>	<p><b>Scientific Assessment Panel</b></p> <ul style="list-style-type: none"> <li>• Periodic comprehensive assessments</li> <li>• Ad hoc reports</li> </ul> <p><b>Socio-Economic Assessment Panel</b></p> <ul style="list-style-type: none"> <li>• Periodic comprehensive assessments</li> <li>• Ad hoc reports</li> </ul> <p><b>Implementing and bilateral agencies</b></p> <ul style="list-style-type: none"> <li>• Technical assistance:               <ul style="list-style-type: none"> <li>- capacity-building and training</li> <li>- policy development</li> <li>- monitoring and reporting</li> </ul> </li> <li>• Best practices and knowledge exchanges</li> </ul> <p><b>Financial resources and mechanism</b></p> <ul style="list-style-type: none"> <li>• Enabling activities:               <ul style="list-style-type: none"> <li>- capacity-building and training</li> <li>- policy development</li> <li>- monitoring and reporting</li> <li>- institutional strengthening</li> <li>- Pilot and demonstration projects</li> </ul> </li> <li>• Incremental costs</li> </ul> <p><b>Implementation and compliance mechanism</b></p> <ul style="list-style-type: none"> <li>• Implementation guidance</li> <li>• Assistance for countries in non-compliance</li> </ul>

## ▶ International agreements for plastics additives

- ▶ A number of additives identified as hazardous to humans and/or the environment are regulated internationally (*Rodrigues et al. 2018*).
- ▶ Stockholm Convention on Persistent Organic Pollutants (POPs)
  - A global treaty to protect human health and the environment from chemicals that remain intact in the environment for long periods.
  - Requires Parties to prohibit, eliminate and/or restrict the production, use, import and export of listed intentionally produced POPs.
  - Currently, the Convention regulates a small fraction of the hazardous additives contained in plastics and plastic waste. Some of these chemicals are still used as a result of exemptions. Moreover, a large number of additives and associated derivatives still do not fall under current regulations.
- ▶ Other additives proven to be harmful such as cadmium, chromium, lead and mercury (regulated under the Minamata Convention on Mercury), which have previously been used in plastic production, are banned in many jurisdictions.
- ▶ The use of the additive bisphenol A (BPA) in plastic baby bottles is banned in many parts of the world.
- ▶ Despite this, dangerous additives are still used in plastics, particularly in LMIC (*UNEP 2021*).

## ▶ A new POP: A high-volume additive called UV-328



- ▶ The **POPs Review Committee (POPRC)** is a subsidiary body responsible for reviewing POPs for listing in the Stockholm Convention.
- ▶ In early 2021 the committee found that **UV-328**, which is a high-volume additive in plastic products such as personal care products and coatings, satisfies all the criteria set out in Annex D, namely **persistence**, **bioaccumulation**, potential or **long-range environmental transport** and **adverse effects** to humans and/or the environment.
- ▶ UV-328 was found in the environment and biota, including in remote areas such as the Arctic and the Pacific Ocean, far from its production and use.
- ▶ UV-328 has been found to be transported with, and may subsequently be released from plastic debris, which is taken up for example by seabirds with subsequent accumulation in their tissue.
- ▶ Taking into account the recommendations of the Committee, a future Conference of the Parties could trigger its **reduction or elimination**.
- ▶ Such a listing would strengthen the Stockholm Convention's role as a key global instrument to tackle the plastic waste crisis.



# ▶ Strategic Approach to International Chemicals Management (SAICM)



## Global Policy Framework for fostering the sound management of chemicals.

- ▶ Adopted in 2006 and includes focal points in 175 governments and 85 NGOs.
- ▶ Supports the achievement of the goal agreed at the **2002 Johannesburg World Summit on Sustainable Development** of ensuring that, by the year 2020, chemicals will be produced and used in ways that minimize significant adverse impacts on the environment and human health.
- ▶ **International Conference on Chemicals Management (ICCM)**, which undertakes periodic reviews of SAICM.
- ▶ 2006 Dubai Declaration on International Chemicals Management.
- ▶ “**Overarching Policy Strategy**” for SAICM.
- ▶ In 2015, the 4th ICCM initiated an inter-sessional process to prepare recommendations regarding the Strategic Approach beyond 2020 with the first meeting of the inter-sessional process held in 2017.
- ▶ Unfortunately, the 5<sup>th</sup> session was postponed due to COVID-19, however four working groups were created to advance the **Beyond 2020 chemicals framework**.

# ▶ Strategic Approach to International Chemicals Management (SAICM)

▶ The main objectives of the Strategic Approach are:

- Risk reduction
- Knowledge and information
- Governance
- Capacity-building and technical cooperation
- Illegal international traffic

▶ Identifies and collaborates on Emerging Policy Issues (EPIs):

Highly Hazardous Pesticides (HHPs)	Nanotechnology
E-waste	Endocrine Disrupting Chemicals (EDCs)
Lead in paint	Environmentally persistent pharmaceutical pollutants
Chemicals in products	Perflourinated chemicals

## ▶ **Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal**

- ▶ The Basel Convention was adopted in 1989 and ratified by 187 states.
- ▶ It is the only global legally binding instrument that specifically addresses plastic waste.
- ▶ The overarching objective of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal is to protect human health and the environment against the adverse effects of hazardous and other wastes.
- ▶ The provisions of the Convention centre around the following principal aims:
  - The reduction of generation and the promotion of environmentally sound management of hazardous and other wastes requiring special consideration, wherever the place of disposal;
  - The restriction of transboundary movements of hazardous and other wastes except where it is perceived to be in accordance with the principles of environmentally sound management;
  - A regulatory system applying to cases where transboundary movements are permissible based on a Prior Informed Consent (PIC) procedure.

## ▶ The Basel Convention – the only global, legally binding instrument to address plastic waste

- ▶ In 2019 the Conference of the Parties enhanced control of plastic waste by amending Annexes II, VIII and IX to the Convention through the so-called **Plastic Waste Amendments**.
- ▶ The Plastic Waste Amendments are expected to have a range of positive impacts across the three pillars of the Basel Convention, namely:
  - **Increased control of transboundary movements (TBM):** By establishing a legally binding framework for the trade in plastic waste, conditions are created for the global trade in plastic waste to become more transparent and better regulated.
  - **Increased environmentally sound management (ESM):** By ensuring that the Convention's provisions on ESM now apply to specified categories of plastic waste, the Amendments provide a powerful incentive to strengthen national infrastructures for the collection, recycling and final disposal of plastic waste.
  - **Increased waste prevention and minimization:** By bringing the listed types of plastic waste under the Convention's provisions pertaining to waste prevention and minimization, the Amendments will help create jobs and economic opportunities, not least by incentivizing innovation, such as in the design of alternatives to plastic and in the phasing out of hazardous additives.

# Workplace level actions to protect workers



## Introduction

Considerations regarding workplace plastic exposures must be integrated into all workplace level actions.

- ▶ **Implement a workplace programme for the sound management of chemicals:** To follow the ILO general blueprint for the sound management of chemicals in the workplace.
- ▶ **Implement a workplace level strategy:** This includes chemical identification and classification, risk assessment and identification of control measures.
- ▶ **Apply the Hierarchy of Controls:** Elimination, substitution, engineering controls, administrative controls and personal protective equipment (PPE).



## ▶ ILO blueprint of a workplace programme

- ▶ The ILO recommends a number of components that make a general blueprint for the sound management of chemicals in the workplace.
- ▶ National guidelines should be considered in the first instance.



## Components of a workplace programme – an overview

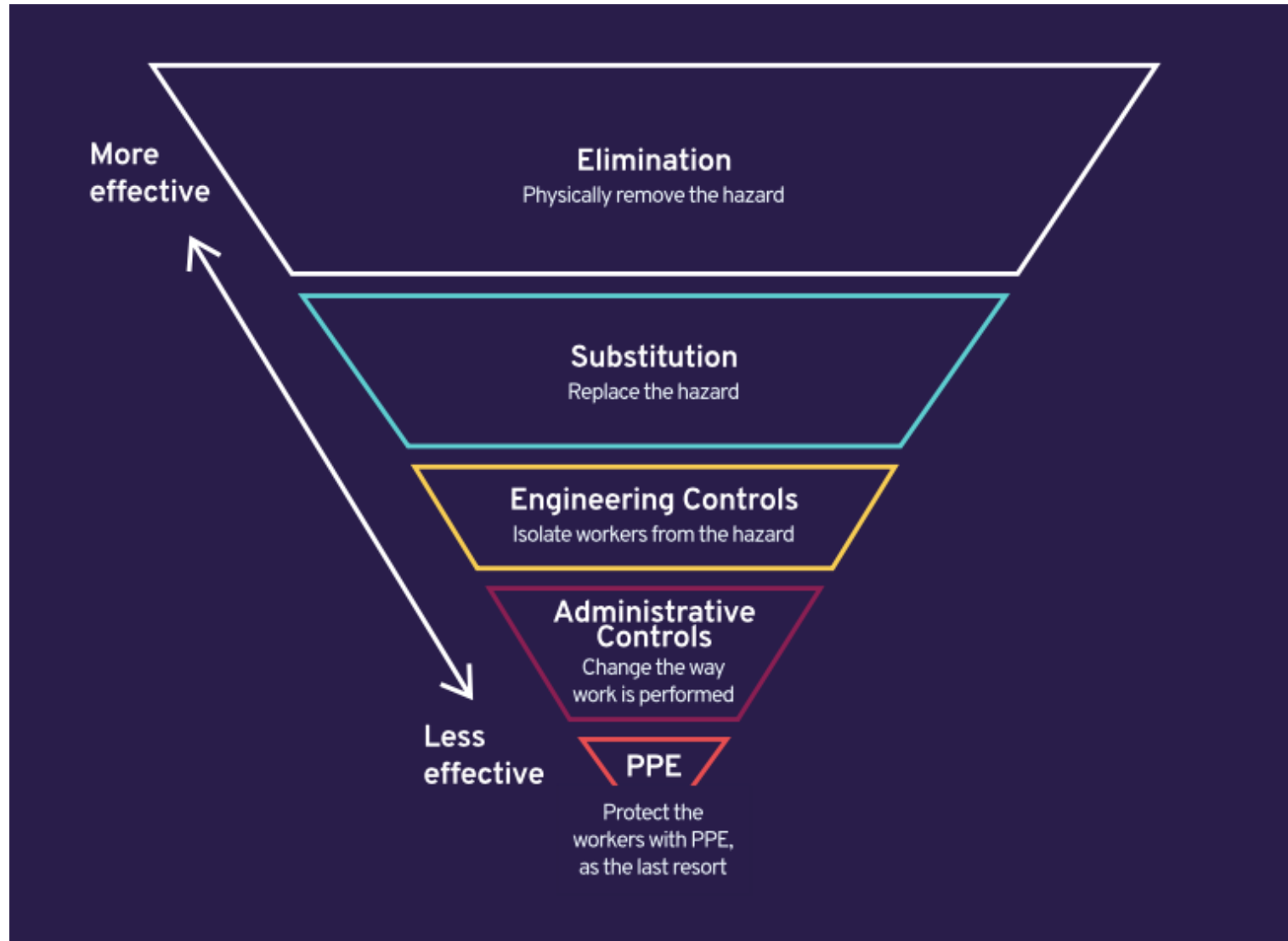
- ▶ General obligations, responsibilities and duties
- ▶ Classification and Labelling following the GHS
- ▶ Chemical Safety Data Sheets
- ▶ Operational Control Measures
- ▶ Design and Installation
- ▶ Work Systems and Practices
- ▶ Personal Protection
- ▶ Information and Training
- ▶ Maintenance of Engineering Controls
- ▶ Exposure Monitoring
- ▶ Medical and Health Surveillance
- ▶ Emergency Procedures and First Aid
- ▶ Investigation, Recording and Reporting of Accidents, Occupational Diseases and Other Incidents



## Implement a workplace level strategy

	STEP 1	STEP 2	STEP 3
<b>CHEMICAL HAZARDS</b> e.g. plastics additives	<b>Identification of chemicals</b> Classification of hazards/labels and safety data sheets	<b>Determination of potential exposures in the workplace</b> Risk assessment	<b>Identification of control measures based on risk assessment</b> Implementation of controls, evaluation of effectiveness and maintenance of level of protection

# Apply the Hierarchy of Controls



# Hierarchy of Controls for polybrominated diphenyl ethers<sup>145</sup> (PBDEs) exposure

<b>Elimination</b>	Eliminate the use of PBDEs in plastics production by using an alternative material to plastic
<b>Substitution</b>	Substitute the PBDE with a less toxic flame retardant chemical
<b>Engineering controls</b>	Use work processes which suppress or contain the PBDE, or limit the area of contamination in the event of spills and leaks e.g. ventilation booths
<b>Administrative controls</b>	Administrative control measures are work systems and practices to provide protection for workers e.g. adjust work tasks or schedules to limit the time workers are exposed to chemicals and create written operating procedures on handling hazardous substances
<b>PPE</b>	Workers should wear appropriate PPE e.g gloves, overalls, masks with filters, and safety glasses, as deemed relevant by risk assessment

# ► Styrene control in fibre-reinforced plastics contact moulding (HSE recommendations)

## ► Assessing the risk

- The measures needed to control vapour levels are dependent on the scale of the manufacturing process and the nature of the articles being produced.
- Use the scoring system to determine the levels of control needed.
- The total will provide a figure, which should then be matched to the score outcome in the next table to decide what levels of control are needed.

**Table 1** Scoring system to be used to determine the levels of control needed

Process			
Hand lay-up or spray lay-up with non-atomising spray gun*	1	Spray lay-up with atomising spray gun*	3
Processing stage			
Not gel coating	1	Gel coating	2
Rate of resin use <sub>r</sub>			
Resin use 5 kg/worker/hour or less	1	Resin use 6–10 kg/worker/hour	2
Resin use 11–15 kg/worker/hour	3	Resin use more than 15 kg/worker/hour	5
Daily exposure			
Exposure up to 4 hours/day	1	Exposure over 4 hours/day	3
Moulding shape and size			
Mouldings flat, up to 1 m <sub>2</sub>	1	Mouldings flat, over 1 m <sub>2</sub>	2
Mouldings deeply concave or convex	3	Mouldings with bulkheads/enclosed areas	5
Workroom size			
Large workroom over 5000 m <sub>3</sub>	1	Medium workroom 500–5000 m <sub>3</sub>	2
Small workroom up to 500 m <sub>3</sub>	3		

# Styrene control in fibre-reinforced plastics contact moulding (HSE recommendations)

- ▶ Action required
  - The measures in this table in nearly all situations will be enough to control the 8-hour time-weighted average exposure to the level currently recognised as being reasonably practicable.
- ▶ Monitoring and maintaining control measures
  - Once the control measures have been put in place, they need to be maintained and monitored for continued effectiveness.
- ▶ Health surveillance
  - However, a biological exposure monitoring programme incorporating measurement of urinary mandelic acid (MA) or phenylglyoxylic acid (PGA) may be useful to determine the effectiveness of control measures.

**Table 2** Control measures to take according to the score from Table 1

Score from Table 1	Ventilation specification	Other measures
6–8	You will need to provide good general ventilation. This means providing a fan to draw in fresh air at one end of the workroom, and a fan at the opposite side at ground level to remove any styrene-laden air.	Replace lids on containers and drums when not actually in use. Organise the work as far as possible so that workers do not impede ventilation airflow and work towards the 'extract' end of the workroom. Provide and ensure the use of suitable gloves, selected on the advice of resin and glove suppliers. Use rollers with splash guards to control droplets.
9–14 and no individual box score of 5	As well as the general ventilation described in the 'Score 6–8' section, you will need to provide local exhaust ventilation (LEV)* close to the work being done. This can be in the form of flexible trunking which should be adjusted to be as close to the moulding surface as possible. To be effective, the work surface should be within the capture zone of the hood and should be flanged for maximum directional effect. Suppliers and designers of capturing hoods need to provide information on the capture zone. If the source is further than two diameters of the hood then it will be ineffective.	Follow the 'Other measures' in the 'Score 6–8' section to reduce exposure.
15 or more or any individual box score of 5	Work in this category is likely to lead to high exposure unless very carefully controlled. In some cases (spray lay-up), work in a purpose-built spray booth will almost always be necessary. For work inside large mouldings where it is difficult to use LEV, or where LEV on its own may not be sufficient, 'push-pull' ventilation* should be used to move styrene-laden air through the moulding towards extract ventilation.	You may need to supplement ventilation with respiratory protective equipment (RPE) <sup>4</sup> or, in exceptional cases, use airline-fed equipment to ensure workers are not over-exposed. <sup>†</sup> Seek specialist advice on these matters.



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# Research priorities

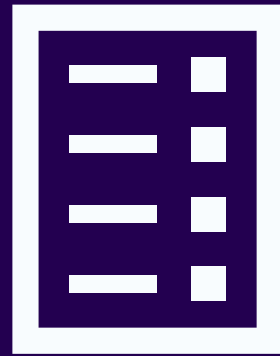


## ▶ Research is urgently needed

**Research is needed in these areas to create evidence-based policies to better protect workers.**

- ▶ The harmful impacts of occupational exposures to different plastics additives.
- ▶ How occupational exposures to microplastics produced by both top-down and bottom-up mechanisms impact worker health.
- ▶ Identifying the industries in the lifecycle of plastics which put workers at the highest risk of harmful plastic exposures.
- ▶ Ascertaining which population groups, in which geographical regions, are most at risk.
- ▶ Developing OELs for the most hazardous plastic additives, as well as microplastics.
- ▶ Finding workplace interventions using the Hierarchy of Controls to protect workers from harmful microplastic exposures.
- ▶ Create risk assessment frameworks for occupational exposure to microplastics.
- ▶ Education and training techniques to best teach all stakeholders about the harmful impacts of plastics exposures.

# End of session activity



Quiz



## Quiz

1. What are most plastics derived from?
2. Name some properties of plastics that make them useful for so many products.
3. How can 70% of polymers be identified?
4. Which industry is the largest user of plastics?
5. What are bioplastics?
6. Give two hazardous chemical exposures in the oil and gas industry.
7. What are some uses of chemical additives?
8. What are endocrine disrupting chemicals?

## Quiz

7. Explain the two mechanisms by which workers can be exposed to microplastics.
8. What is a circular economy for plastics?
9. Define the Globally Harmonized System of Classification and Labelling of Chemicals (GHS)?
10. What is the goal of the ILO's Guidelines for a Just Transition?
11. What is the Stockholm Convention and how does it relate to plastic additives?
12. List the five levels of the Hierarchy of Controls.
13. Suggest some priority areas for future research.

## Key ILO resources

- ▶ [Exposure to hazardous chemicals at work and resulting health impacts: A global review \(2021\).](#)
- ▶ [World Employment and Social Outlook: Greening with Jobs \(2018\).](#)
- ▶ [The employment impact of climate change adaptation: Input document for the G20 Climate Sustainability Working Group \(2018\).](#)
- ▶ [The Sound Management of Chemicals and Waste in the World of Work \(2019\).](#)
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- ▶ [Major hazard control: A practical manual \(1993\).](#)
- ▶ [Diagnostic and exposure criteria for occupational diseases - Guidance notes for diagnosis and prevention of the diseases in the ILO List of Occupational Diseases \(revised 2010\) \(2022\).](#)