Climate change and plastics pollution

Synergies between two crucial environmental challenges

POLICY HIGHLIGHTS

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Key findings

How are climate change and plastic pollution interlinked?

- The production, conversion and waste management of plastics generate about 4% of total greenhouse gas (GHG) emissions. Of these, 90% can be attributed to the production and conversion stage of the plastics lifecycle.
- Most plastics are currently produced with fossil fuels (93%). The amounts made from recycled plastics are 6% and the remainder are biobased plastics.
- Substituting biobased plastics for fossil-based plastic production would lead to a direct GHG emissions decrease. However, the production of biobased plastics requires additional land leading to GHG emissions related to deforestation.
- Waste management practices also affect the GHG intensity of plastics via their end-of-life treatment. In 2019, emissions from incineration accounted for 70% of total end-of-life emissions while those from recycling accounted for 22%. Recycling plastics reduces GHG emissions by lowering the demand for primary plastics, which have a higher carbon footprint. The average

reduction of GHG emissions across regions amounts to more than two-thirds compared to the production of an equivalent primary plastics polymer.

- In the absence of more stringent policies GHG emissions are projected to double by 2060, while global plastic use is projected to triple, leading to a doubling of plastic leakage to the environment.

What are the interactions between the policies to reduce greenhouse gas emissions and plastic pollution?

- Public policies on climate change mitigation and curbing plastic pollution have mostly developed independently. The two issues are linked and policy makers can exploit synergies.
- The OECD's *Global Plastics Outlook: Policy Scenarios to 2060* published in 2022 looks in depth at this question through stylised policy scenarios for the 2060 horizon:
  - A *Global Ambition* scenario to minimise plastic leakage to the environment also reduces plastics lifecycle GHG emissions by 50% in 2060 compared to a Baseline scenario. These reductions are achieved through lower levels of plastic production and a higher share of secondary (recycled) plastics, which is less emission intensive than primary plastics. In this scenario, mismanaged plastic waste, the main source of plastic leakage, decreases by 96%, leading to a 98% decrease of total plastic leakage to aquatic environments.
  - A *Climate Mitigation* scenario to reduce global GHG emissions by around one-third by 2060 compared to the Baseline. In this scenario, plastics lifecycle GHG emissions decrease by 31% due to a shift to less carbon intensive energy sources used to produce plastics, while mismanaged plastic waste, the main source of plastic leakage decreases by 3%.
  - When implemented together, the *Global Ambition* on plastics and *Climate Mitigation* scenarios result in synergies that can maximise the mitigation of plastics lifecycle GHG emissions. Combined, the policies included in the two scenarios are projected to reduce plastics lifecycle GHG emissions to below 2019 levels by 2060 (-67% change compared to baseline in 2060), and mismanaged plastic waste by 96%.

The **Global Plastics Outlook** models two policy packages, one on plastics and one on climate, to understand their environmental and economic interactions by 2060.

The *Global Ambition* policy scenario explores a very stringent policy package that aims to reduce plastic leakage to near zero by 2060. It comprises a mix of globally implemented fiscal and regulatory policies targeting all phases of the plastics lifecycle: plastic taxes, ecodesign for durability and repair, enhanced recycling through waste management, recycled content targets, Extended Producer Responsibility (EPR) for packaging, electronics, automotive and wearable apparel, improved plastic waste collection and improved litter collection.

The *Climate Mitigation* scenario models the impact of major decarbonisation instruments: carbon pricing and the structural transformation of the power sector. In this scenario, carbon pricing curbs GHG emissions from fossil fuel combustion and industrial processes in the whole economy, including households and all sectors, while the structural transformation of the power sector reduces a large share of global GHG emissions due to the deployment of low-GHG power generation technologies.

The *combined Global Ambition and Climate Mitigation* scenario implements both policy packages simultaneously.

The scenarios are compared to the *Baseline* business-as-usual projections under current policies.

Key findings

How can policy makers take advantage of the synergies between the two issues?

- The climate mitigation and plastic pollution policy domains have **synergies** because climate change and plastic policies influence plastics lifecycle GHG emissions through different channels. Climate policies reduce the GHG intensity of plastics production and waste management and lead to lower plastic production, while plastic policies lead to emission changes through lower plastic production, an increased share of recycled plastics and improved waste management systems.

- Both policy agendas need to be implemented to address the environmental crisis: climate mitigation policies cannot be used as a substitute for plastics policies to reduce plastic leakage, and plastics policies cannot replace dedicated climate mitigation action.

- **High ambition on both goals means tackling both issues globally**. The plastics lifecycle generates about 4% of total GHG emissions. Reducing plastic-related emissions will be far from sufficient but nevertheless indispensable to achieve ambitious climate mitigation goals, such as net-zero emissions.

- Policy makers can combine efforts to fight plastic pollution and mitigate climate change by:
  - Strengthening the ambition of domestic policies to address plastics pollution
  - Supporting the decarbonisation of the plastics lifecycle
  - Fostering innovation in plastics production and waste management
  - Strengthening the secondary plastics market
  - Tapping into the complementarity of plastics and climate policies

Climate change and plastic pollution are among the most pressing environmental challenges of the 21st century

The improper disposal of plastic products and plastic pollution cause wide-ranging damages to ecosystems and human health. Plastics throughout their lifecycle emit greenhouse gases (GHG), contributing to climate change.

In recent years, growing awareness on plastic pollution has paved the way for stronger policy intervention. Many countries around the world are now implementing policies that aim at reducing the negative environmental impacts associated with the different stages of the plastics lifecycle.

In February 2022, the United Nations Environment Assembly adopted a historic resolution to develop an international legally binding instrument with the ambition to complete negotiations by the end of 2024. Less than a month later, on 31 March 2022, the Declaration of the OECD Environment Ministerial Meeting committed to develop comprehensive and coherent lifecycle approaches to tackle plastic pollution and promote co-operation internationally.

In parallel, many countries are pledging to achieve carbon neutrality, namely balancing carbon emitted to the atmosphere and sequestrated in carbon sinks, by the middle of the century. 193 States and the European Union have joined the Paris Agreement, pledging to substantially reduce GHG emissions to limit the global temperature increase in this century to 2 degrees Celsius.

Agendas on climate change mitigation and plastic pollution have mostly developed independently. However, the two issues are linked and policy makers can exploit synergies by tapping into the complementarity of climate and plastics policies.

The links between plastics and climate change

The plastics lifecycle is fundamentally linked to climate change

Plastics generate GHG emissions throughout their lifecycle, from their production, which mostly relies on fossil fuels transformed through energy-intensive processes, to their management as waste, which requires energy and generates direct emissions (Figure 1).

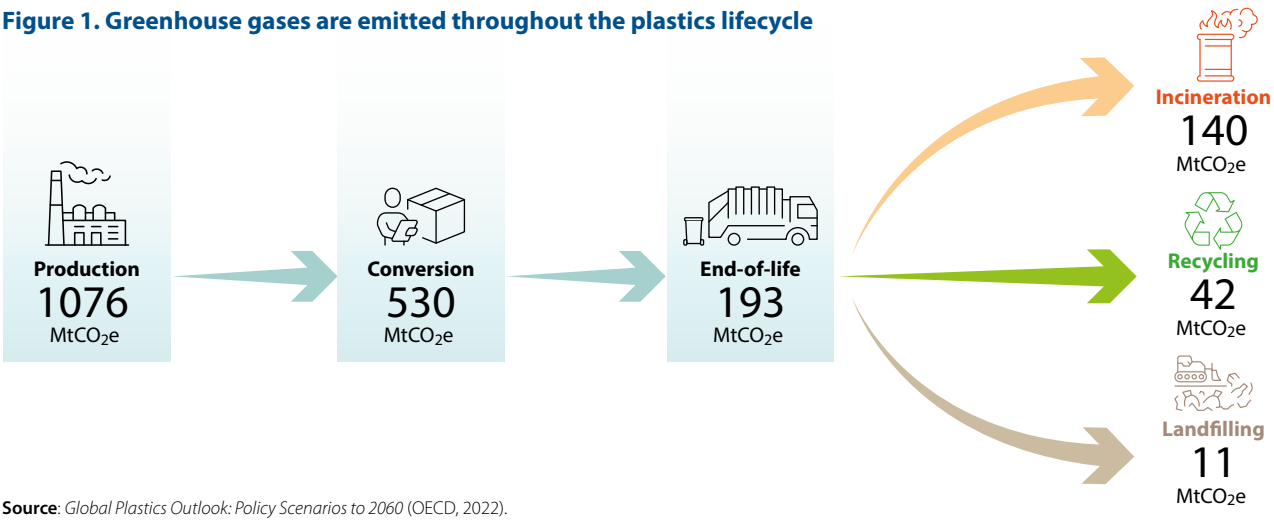
Due to the fossil-based origins of most plastics and the high energy consumption during refining, 90% GHG emissions from plastics can be attributed to the production and conversion stage.

In 2019, total GHG emissions related to fossil-based plastics throughout their lifecycle were 1.8 gigatonnes of carbon dioxide equivalent ($GtCO_2e$), or 3.7% of global emissions. With increasing plastics use and waste, these emissions are projected to more than double by 2060, reaching 4.3 $GtCO_2e$, or 4.5% of global GHG emissions, in the absence of new policies.

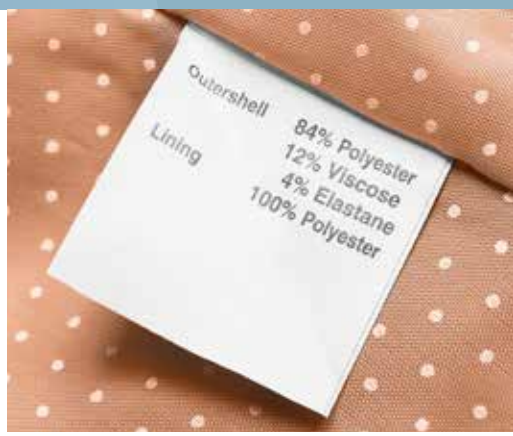
The impact of plastic leakage on GHGs is not incorporated in these estimates. However, recent research based on experimental data estimated that degradation in the environment and non-sanitary landfilling leads to methane emissions of roughly 2 million metric tonnes (Mt) CO_2e per year.

Furthermore, as regards GHG emissions from the use phase of products, plastics may contribute to reduce certain emissions due to light weighting but might create other environmental challenges related to waste management. These considerations, however, can only be taken into account on a product by product basis.

Figure 1. Greenhouse gases are emitted throughout the plastics lifecycle



Source: *Global Plastics Outlook: Policy Scenarios to 2060* (OECD, 2022).



Fossil-fuel based primary plastics strongly dominate current production and use

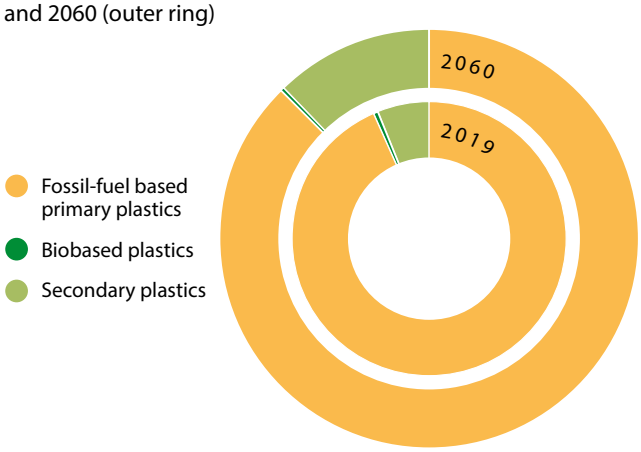
Fossil-fuel based primary plastics represent by far the largest share of plastics production, accounting for 93% of plastics production in 2019 (Figure 2). Despite having substantially increased in the last 20 years, secondary (i.e. recycled) plastics still represent a limited share of plastics, accounting for around 6% of plastics production in 2019. Biobased plastics, i.e. plastics derived from biomass such as corn, sugarcane, wheat or residues of other processes, are still very limited, representing around 0.6% of plastic production.

Although secondary plastics are projected to grow at a faster rate than primary plastics, they are still expected to only make up 12% of the total share of plastics use in 2060 with current policies. Without new policies, biobased plastics will only represent 0.5% of total plastics use in 2060.

Plastic emissions also differ by polymer. The largest contributors to emissions are fibres used for textiles and clothes, followed by polypropylene (PP), used for a large variety of applications, including food packaging and moulded parts in vehicles. Production of low-density polyethylene (LDPE), used for instance in plastic bags or dispensing bottles, is the third-highest emitter.

Figure 2. Plastic production is dominated by fossil-fuel based primary plastics

Plastics production shares by type of plastics, 2019 (inner ring) and 2060 (outer ring)



Source: *Global Plastics Outlook: Policy Scenarios to 2060* (OECD, 2022).

Are biobased plastics a solution?

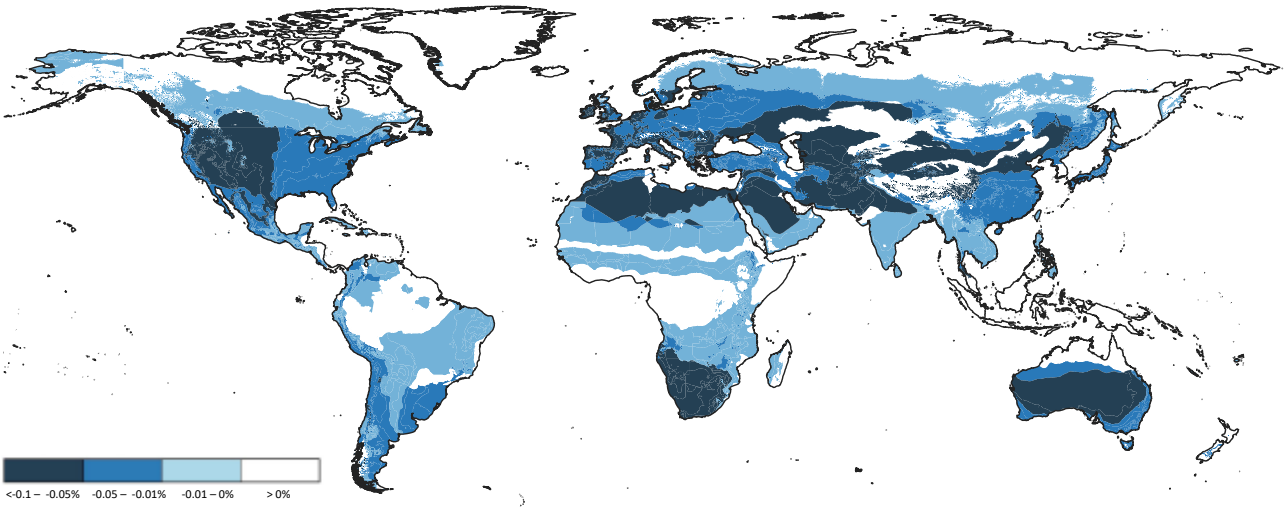
The net environmental effects of the substitution of fossil-based plastics by biobased plastics are not straightforward due to their potential to drive land-use changes, such as deforestation, that may lead to significant GHG emissions and to reduction of carbon sinks.

In a scenario that induces higher demand for biobased plastics, global demand for feedstock crops, such as corn, sugarcane or wheat, increases by 2060, driving up cultivated land. This comes at the expense of both managed land uses (pasturelands and forest plantations) and unmanaged land uses (e.g. natural forests, shown in Figure 3).

Currently 0.7 million hectares or 0.02% of global agricultural land is used for growing feedstock for biobased plastics. Any policies to stimulate further biobased plastics must be chosen carefully to limit implications for land use and GHG emissions. The overall environmental outcome of upscaling biobased plastics will only be positive when a combination of global commitments and locally enforced regulatory measures succeeds in restraining the conversion of natural areas into agricultural land.

Figure 3. Changes in land use with a higher global market share (3%) of biobased plastics

Change in unmanaged forestland area (% with respect to *Baseline*), 2060



Source: *Global Plastics Outlook: Policy Scenarios to 2060* (OECD, 2022).

Improved waste management can lower the GHG intensity of plastic end-of-life treatment

Plastic end-of-life emissions account for about 10% of plastics lifecycle emissions and vary significantly by disposal option. In 2019, incineration accounted for more than 70% of the total end-of-life emissions, while recycling accounted for 22% and landfilling for 6%.

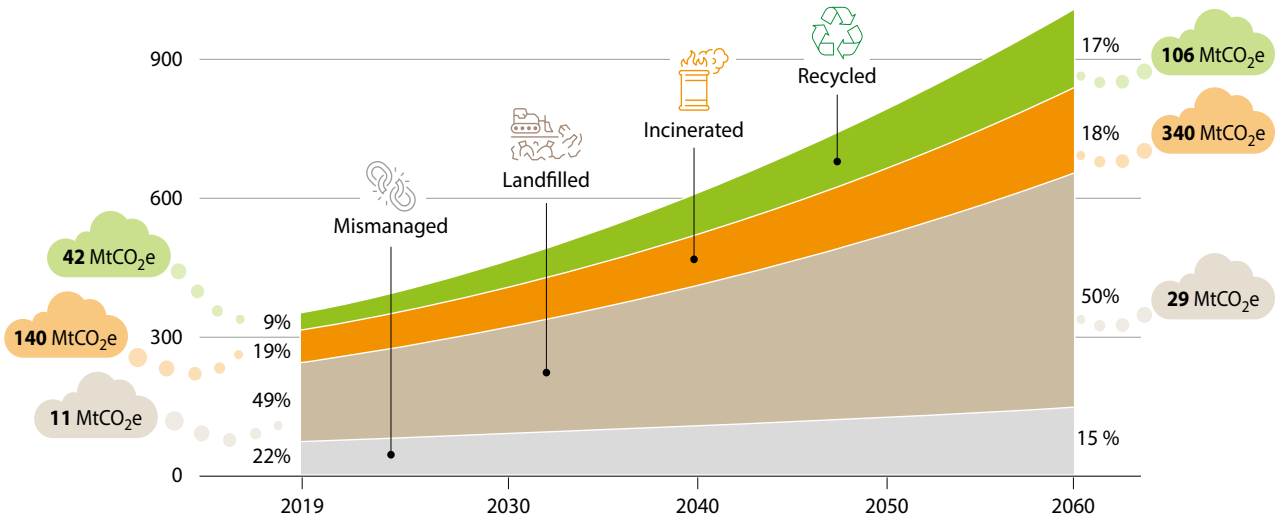
Of the various end-of-life fates, incineration emits the most GHG, although some of these emissions might be offset if recovered through waste-to-energy processes. However, the mitigation potential heavily depends on each country's energy generation mix. Sanitary landfilling, on the contrary, is the least GHG-intensive end-of-life fate for plastics. Recycling does emit more GHG than sanitary landfilling, but also enables the production of secondary plastics that can reduce emissions by substituting for primary plastics. The GHG emissions avoided by recycling and the subsequent production of secondary plastics depend on the polymer and region (mostly on the energy mix of the region's recycling sectors). The average reduction of GHG emissions across regions amounts to at least 1.8 tonne of CO_2e for a tonne of polymer produced or a reduction of more than two-thirds compared to the production of the primary equivalent.

Policies currently in place largely vary across countries but include policy instruments such as Extended Producer Responsibility (EPR), landfill or incineration taxes, deposit-refund systems or pay-as-you-throw programmes. They will lead to improvements in waste management systems which will result in a higher share of recycled waste and in less mismanaged waste (Figure 4). These changes imply fewer emissions per unit of plastic waste. However, plastic end-of-life emissions still increase due to the projected increase in the overall volume of plastic waste.

New emerging techniques for recycling might facilitate the expansion of secondary plastics markets and change their GHG emission intensity, even though, currently, their environmental impacts are far from being fully understood. This is particularly the case for plastic-to-plastic chemical recycling, which might allow to increase plastic recycling rates, but also increase the related GHG emissions compared to current mechanical recycling techniques.

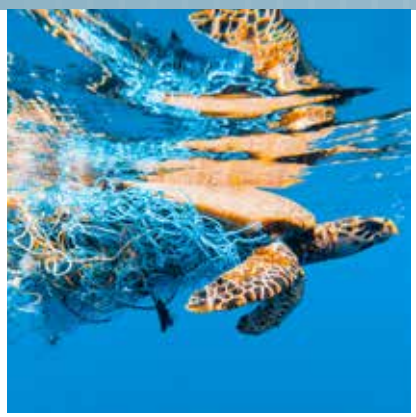
Figure 4. Plastic end-of-life emissions are projected to increase despite waste management improvements

Plastic waste in million tonnes (Mt) and greenhouse gas emissions in Mt of carbon dioxide equivalent ($MtCO_2e$) by waste management category, *Baseline scenario*



Source: *Global Plastics Outlook: Policy Scenarios to 2060* (OECD, 2022).

Creating synergies in policies to mitigate climate change and plastic pollution



Policies to reduce plastic pollution have co-benefits for climate change mitigation

Reducing plastic leakage to the environment needs policies that address the whole lifecycle of plastics: restraining demand, enhancing recycling and closing leakage pathways.

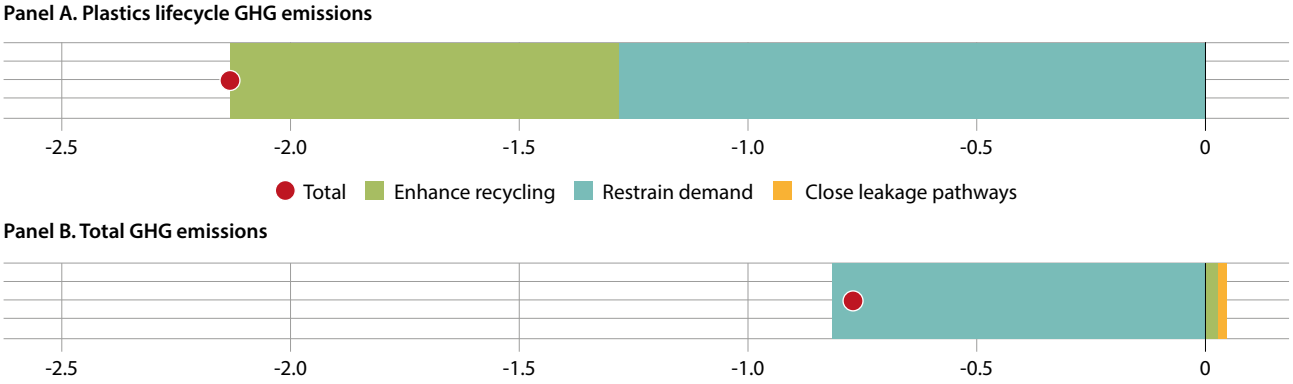
A scenario with the *Global Ambition* to minimise plastic leakage to aquatic environments by 2060 also implies avoiding a major increase in primary plastics use and reducing plastic waste. Without aiming directly at reducing GHG emissions, this scenario could reduce plastics lifecycle GHG emissions by 50% (2.1 Gt CO_2e) compared to the *Baseline* scenario in 2060 (Figure 5). Plastics lifecycle emissions decrease mostly thanks to the reduction in plastics use, which results from policies that restrain plastics use (e.g. plastic taxes), but also from a shift to secondary plastics. Thanks to policies that aim at improving waste management, mismanaged waste is projected to decline, while more waste is incinerated, landfilled and recycled.

The reduction of plastic lifecycle emissions from policies to address plastic pollution is indispensable to reach high ambition climate scenarios, including the Net-Zero emissions scenarios.

Global emissions take all sectors into account and respond to different drivers compared to plastics-related emissions. If the decrease in plastics use was strongly compensated for by the use of more GHG-intensive materials, global emissions would increase. However, the *Global Ambition* scenario is projected to decrease global GHG emissions by 0.8% (0.8 Gt CO_2e) compared to the *Baseline* scenario in 2060.

Figure 5. Restraining plastics demand contributes the most to emission reductions

Global Ambition variation from *Baseline* in gigatonnes of carbon dioxide equivalent (Gt CO_2e), 2060



Source: *Global Plastics Outlook: Policy Scenarios to 2060* (OECD, 2022).

Climate change mitigation policies have limited impacts on plastics use

A *Climate Mitigation* scenario, in which the world average carbon price progressively rises to USD 69 /tCO_2 in 2060 and the power sector reduces the share of fossil-based power generation from 69% in 2019 to 15% in 2060, reduces global GHG emissions by around one-third by 2060 compared to the *Baseline* (Figure 6).

The *Climate Mitigation* scenario has a significant impact on plastics lifecycle GHG emissions, decreasing them by 31% (1.3 Gt CO_2e) in 2060 compared to *Baseline* but has limited impact on plastics use.

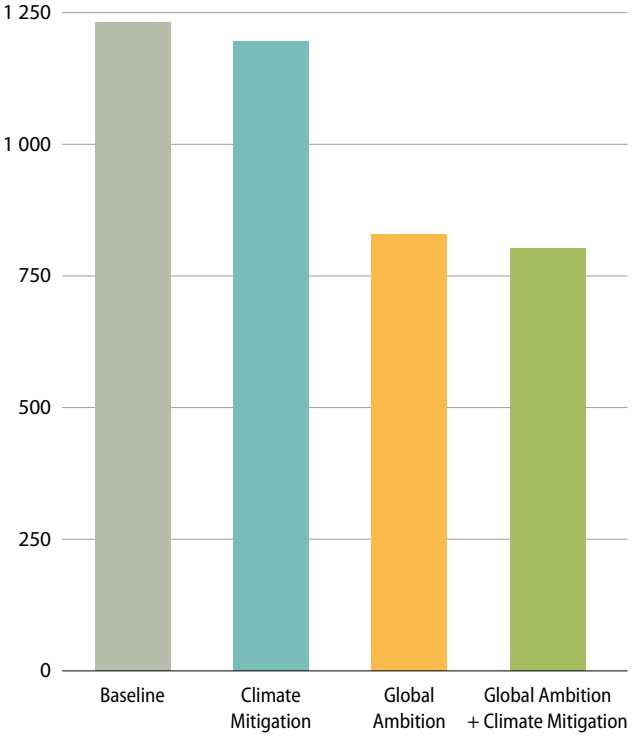
The main channel through which the *Climate Mitigation* scenario affects plastics lifecycle GHG emissions is a shift of energy use in plastics-related activities (production and conversion, and to a lesser extent end-of-life) from more to less carbon intensive sources, such as electricity and gas. More energy-intensive primary plastics production is more affected than secondary production but the impact on overall plastics use is limited.

Recycling is the only disposal option that is affected by carbon pricing – because GHG emissions from incineration are mostly direct emissions and not related to energy use, and because emissions from sanitary landfilling are very low.

When *Climate Mitigation* is added to *Global Ambition* on plastics, the results are similar in that the change in global plastics use is limited.

Figure 6. The *Climate Mitigation* scenario alone has limited impact on global plastics use

Global Plastics use (Mt), 2060



Source: *Global Plastics Outlook: Policy Scenarios to 2060* (OECD, 2022).

Creating synergies in policies to mitigate climate change and plastic pollution

Joint action can harness important synergies between climate mitigation and plastics policies

Climate change mitigation policies and plastics policies influence plastics lifecycle GHG emissions through different channels – the GHG intensity of plastics production for the former, and the decrease in plastics use for the latter. This means that the two sets of policies have **synergies** for maximising the mitigation of plastics lifecycle GHG emissions.

Combining both policy packages reduces GHG emissions from the plastics lifecycle by two-thirds compared to the *Baseline*, by 2.8 Gt CO_2e (Figure 7). The combined policy package increases even further the share of secondary plastics in total plastics use: both primary and secondary plastics use decrease, but primary plastics use decreases more than secondary because they are more energy intensive. This shows synergies in the reduction of primary plastics production from *Climate Mitigation* policies, which would be further enhanced with more stringent climate policies.

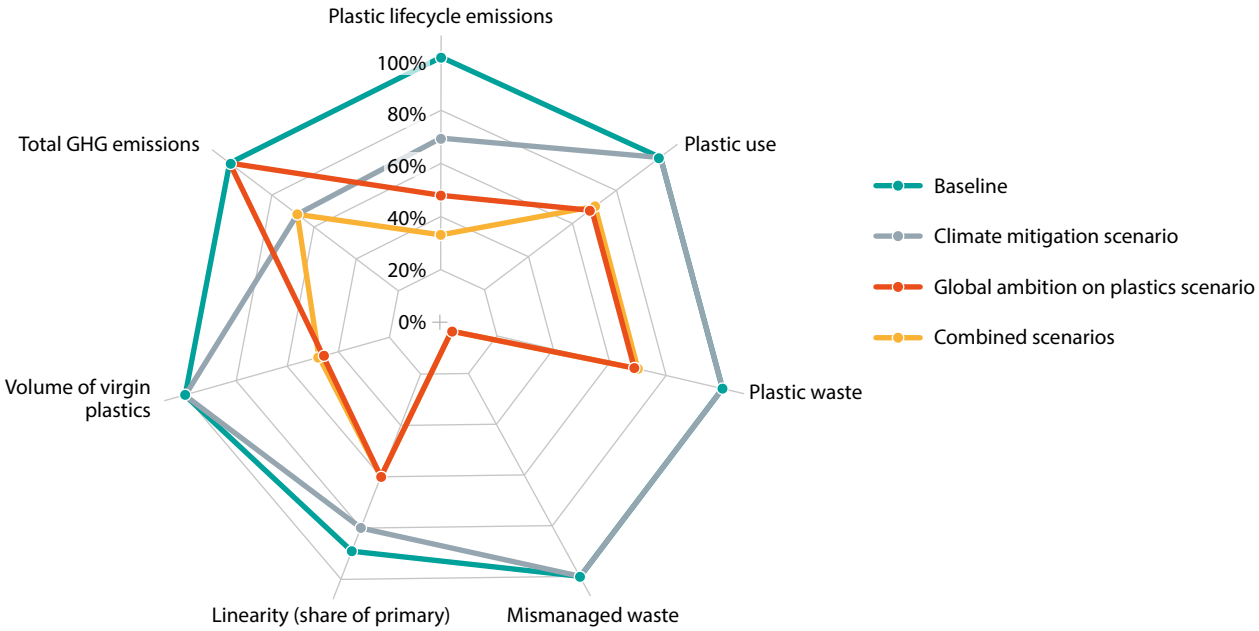
Looking beyond plastics lifecycle GHG emissions, the *Climate Mitigation* scenario reduces global GHG emissions by 31.6 Gt CO_2e in 2060, which corresponds to a 33% reduction.

Policies to mitigate climate change and curb plastic pollution show **complementarity** in the environmental issues they address (Figure 8). The *Climate Mitigation* scenario impacts both total and plastics-related GHG emissions. The *Global Ambition* scenario reduces plastics use, waste and mismanaged waste.

Both policy agendas need to be implemented to address the environmental crisis: climate mitigation policies cannot be used as a substitute for plastics policies to reduce plastic leakage, and plastics policies cannot replace dedicated climate mitigation action.

The plastics lifecycle generates about 4% of total GHG emissions. Reducing plastic-related emissions will thus be far from sufficient to achieve ambitious climate mitigation goals. At the same time, these emission sources need to be addressed to achieve ambitious climate goals such as net-zero emissions.

Figure 7. The *Global Ambition* and *Climate Mitigation* scenario show complementarity and synergies



Note: All indicators are presented as a percentage of baseline value (baseline = 100%), except for linearity which shows the actual share of primary plastics in global use.

Source: *Global Plastics Outlook: Policy Scenarios to 2060* (OECD, 2022).

What can policy makers and stakeholders do?

Strengthen the ambition of domestic policies to address plastics use. These results suggest that the most straightforward way of mitigating GHG emissions from the plastics lifecycle is to slow down the increase in global plastics use and waste. In addition to mitigating environmental impacts of plastics leakage, countries could get closer to achieving their climate objectives.

Support decarbonisation of the plastics lifecycle. Reducing the energy-intensity of plastics production and increasing the share of secondary plastics can provide significant reduction in GHG emissions. Other mitigation options include increasing the availability and use of secondary plastics; decarbonising production and conversion; as well as waste treatment processes, by, among others, an increased use of electricity as a replacement for fossil fuels, combined with a decarbonisation of electricity generation.

Foster innovation in plastics production and waste management. Much more ambitious policies are needed to direct technological change towards closing plastics loops and reducing leakage to the environment in a climate-friendly way. To ensure strong demand for circular plastics, investments in innovation should go hand in hand with education, environmental awareness, financial incentives for behavioural change and binding regulations that should be adapted to the local context.

Strengthen the secondary plastics market. Markets for secondary plastics remain vulnerable. Policies to support the supply and demand for secondary plastics include taxes on non-recycled plastic waste and recycled content targets.

Tap into the complementarity of plastics and climate policies. When implemented jointly, policies to reduce plastics leakage and climate policies produce synergies in reducing GHG emissions from plastics. However, climate mitigation policies cannot be used as a substitute for plastics policies to reduce plastic leakage, and plastics policies cannot replace dedicated climate mitigation action.

Further reading

IEA (2022), *World Energy Outlook 2022, IEA*, Paris, https://doi.org/10.1787/20725302

OECD (2023), Cost and financing for a future free from plastic leakage, Policy Highlights, https://www.oecd.org/environment/plastics/Highlights-Cost-and-financing-for-a-future-free-from-plastic-leakage.pdf.

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Agendas on climate change mitigation and plastic pollution have mostly developed independently. However, the two issues are linked. A key question in this context is: How do policies addressing climate change mitigation and plastic pollution interact? And how can policy makers make use of these interlinkages?

These Policy Highlights provide a forward-looking perspective to address the interactions between climate change and plastics, drawing on the two *OECD Global Plastics Outlook* reports. The *Global Plastics Outlook: Economic Drivers, Environmental Impacts and Policy Options* quantifies current trends (up to 2019) in plastics use, waste generation, plastic-related GHG emissions and leakage, and identifies four policy levers to curb the environmental impacts of plastics. The *Global Plastics Outlook: Policy Scenarios to 2060* presents a set of coherent projections on plastics to 2060, including plastics use and waste as well as the environmental impacts linked to plastics and plastic-related GHG emissions. By identifying policy scenarios on climate and plastics, the Outlooks allow for a better understanding of the interactions and complementarities between the two environmental challenges.

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OECD Environment Directorate, May 2023