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Policy Paper

Contours of an International Plastics Climate Club

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Lukas Hermwille & Alexander Diek

Wuppertal Institute
for Climate, Environment and Energy

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Key Messages

- In order to achieve the Paris Agreement's objectives, a fundamental transformation of the global plastics industry is required. Four complementary strategies will be necessary to achieve climate neutrality in the sector: 1. Utilizing renewable and low-carbon energy inputs, 2. Increasing recycling, 3. Using alternative feedstocks, and 4. Reducing demand.
- The existing global governance landscape for plastic hardly addresses greenhouse gas emissions explicitly. Overall, the global governance remains patchy and insufficient. Governance institutions related to the use of renewable energy and demand reductions are lacking in particular. Ongoing negotiations of the global plastic pollution treaty might remedy some but not all of the identified gaps.
- An international plastics climate club could foster climate neutrality in the sector. It could provide guidance and signal through specific targets. It could set rules for collective action, e.g., through standards for green polymers, leverage trade measures to incentivize trade in more recycling-friendly staple plastics. It could create a transparency framework to establish a more robust information base for future, more far-reaching commitments. It could leverage means of implementation especially for developing countries, e.g., through a packaging and single-use plastic fund that is fed through a surcharge on such plastic products and funds their mechanical or chemical recycling. And finally, the club could create knowledge and learning by systematically evaluating policy instruments and acting as a policy learning accelerator.
- A plastic climate club must not compete with the ongoing negotiations for the plastic pollution treaty. Club members could form a bargaining club to strengthen climate change mitigation within the treaty negotiations and other existing environmental agreements. The club should be seen as complementary to the ongoing negotiations for the plastic pollution treaty and a potential backstop against their failure.

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Introduction

To meet the goals of the Paris Agreement, industries globally must undergo transformative processes towards climate neutrality (Rissmann et al., 2020). Despite the plastic sector's massive environmental impact it has received comparatively limited scrutiny, especially from a global governance perspective (Bashmakov et al., 2022). In this article survey the existing governance landscape and sketch the contours of a plastics climate club as an international arrangement that is complementary to both the Paris Agreement and the plastic pollution treaty that is currently under development (UNEP, 2023b).

Over the past 70 years, global plastics production grew rapidly, with an average annual growth rate of 8.4%, showing a strong upward trajectory (Bashmakov et al., 2022). Plastic represents the predominant output category within the petrochemical industry, which currently consumes approximately 14% of petroleum and 8% of natural gas (IEA, 2018). In many emerging economies, coal is also used as a source for electricity and heat supply. Cabenard et al. (2022) estimate that in 2015 nearly 50% of the carbon footprint of the plastic industry was attributable to coal. Overall, the plastic sector accounted for 3.8% – 4.5% of global GHG emissions in the same year (Stegmann et al., 2022; Zheng & Suh, 2019). If current patterns persist unabated, associated emissions are projected to increase fourfold by the year 2050 (Stegmann et al., 2022).

Recent investments in expanding production capacity are based on petroleum and fossil gas while investments in innovative low-emission technologies are insufficient, which bears the risk of locking the industry on a carbon-intensive pathway (Bauer & Fontenit, 2021). Thus, the heavy reliance on fossil-based feedstocks, the minimal rates of recycling, and the substantial emissions stemming from petrochemical processes pose significant challenges in achieving net-zero emissions by 2050 (Bashmakov et al., 2022).

Moreover, plastic is the only major area in which major petrochemical companies still see opportunities for long-term growth. The OECD projects that plastic use will grow threefold from 2019 to 2060 in a business-as-usual scenario and still almost double in their most advanced "Global Ambition" policy scenario (OECD, 2022b). Meanwhile, demand for oil and gas is projected to decline as electricity is increasingly generated from renewable energy sources while transport as well as building heating are being electrified. In other words, plastics are the last resort of the fossil fuel industry in terms of long-term growth and hence we should anticipate a fierce rear-guard battle of the declining industry (Rootzén et al., 2023; Tilsted et al., 2023).

To still achieve the transformation of the industry in line with the objectives of the Paris Agreement, international cooperation is necessary (Bashmakov et al., 2022). Global governance arrangements can help create an enabling environment that facilitates low-carbon innovation and supports companies to invest in alternative technologies and practices that align with the ambitious decarbonization pathways required to limit global warming to well below 2°C (OECD, 2022a; Otto & Oberthür, 2022; Tilsted et al., 2023). As we shall demonstrate, the current governance landscape is insufficient in this regard. But a global plastics climate club may be a promising avenue for enhancing global governance.

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Climate Clubs: intellectual history and political outlook

The concept of climate clubs has been featured prominently by economists. Nobel laureate William Nordhaus proposed a carbon pricing club in which member states cooperate on carbon pricing e.g., through a joint emissions trading system. Imports from non-members are then imposed with a duty reflecting the costs of carbon so as to avoid "carbon leakage", i.e., the relocation of carbon-intensive industries to regions not covered by carbon prices or other climate-related regulations. The core idea of that club is to have a club good or benefit that is excludable. In the proposed carbon-pricing club the absence of such trade measures among club members would be the benefit – or "club good" – incentivizing club membership (Nordhaus, 2015).

Even a bit earlier, political scientists and scholars of international law had also called for the establishment of a climate club, albeit for different reasons. They saw a climate club as a potential exit from the stalling climate negotiations. A club could unite a smaller subset of forerunners and provide a legally binding foundation for international cooperation on climate action avoiding the cumbersome consensus-based decision making at the UNFCCC (Ott, 2014; Weischer et al., 2012).

Falkner et al. (2022) differentiate between three types of clubs: normative clubs rallying support and signalling resolve for climate ambition on a generic level, bargaining clubs facilitating negotiations of common objectives, and transformative clubs reshaping incentive structures and overcoming free riding. The authors find empirical examples for both normative and bargaining clubs but not for truly transformative ones conforming to the vision of the early proponents of climate clubs.

However, climate clubs are not exclusively a theoretical object. In a recent study Morin et al. (2023) found that more than 60% of the 2097 surveyed international environmental agreements contain trade-related provisions which generate club goods for their members and can therefore be considered "de facto environmental clubs". And more political initiatives are under way to create climate clubs or club-like arrangements. The most prominent example may be the climate club that was established as a result of the 2022 G7 summit in Germany. The club is scheduled to be launched formally at COP28 in late 2023 comprising more than 27 countries including several emerging and developing countries. The terms of reference of this club highlight cooperation on industrial transformation as one of its priority areas (G7, 2022). The second club-like arrangement is the Global Agreement on Sustainable Steel and Aluminium (GASSA) currently under negotiation between the EU and the United States. This agreement is supposed to combine climate change mitigation with trade-related measures, particularly addressing global overcapacity in the steel sector. While the negotiations are so far bilateral, the original joint statement expressly invites other parties to join the agreement (United States of America & European Union, 2021).

In that vein, Hermwille et al. (2022) have proposed the idea of sectoral decarbonization clubs addressing specific sectoral transformation challenges. Such a focus on more specific sectoral "systems transformations" have also been highlighted as a result of the technical phase of the first global stocktake under the Paris Agreement (UNFCCC, 2023) and as an issue for governance reform to achieve the SDGs (Biermann et al., 2023).

To conclude, the concept of climate clubs has received substantial interest both in academia and more recently also in international diplomacy. Especially when focused on specific sectoral themes, it promises to be a vehicle for

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circumventing gridlock in large governance regimes and enabling narrow and deep cooperation to advance climate action overall.

Research Design

The objective of this paper is to propose key design options of an international climate club that enables and facilitates the climate transformation of the plastics industry. To achieve this, we need to address the following research questions:

- How can the global plastic industry be transformed towards a sustainable and low-carbon production system and which strategies exist to achieve this transformation?
- Which global governance institutions exist that address the aforementioned decarbonization[1] strategies and which governance gaps persist?
- How could a plastic climate club close the identified governance gap and complement the existing governance landscape?

To address these questions, we first review the existing literature regarding the climate transformation of the plastic industry and derive four broad and complementary strategies for achieving climate neutrality in the plastic sector: (1) transitioning energy inputs for plastic production and manufacturing to renewable and low-carbon sources, (2) increasing and improving recycling, (3) introducing low-emission alternative feedstocks for plastic production, and (4) reducing the overall demand for plastics.

In a second step, we survey the existing governance landscape building on previous comprehensive work by Raubenheimer and Urho (2022), complementing it with insights from adjacent studies (Bauer, Tilsted, Deere Birkbeck, et al., 2023; Oberthür, Khandekar, et al., 2021; Otto & Oberthür, 2022) and reviewing inputs and submissions to the ongoing negotiations of the plastic pollution treaty provided by governments and stakeholders.

To structure the discussion of design options for the proposed plastics climate club, we employ the governance functions framework proposed by Oberthür et al. (2021) and relate it again to the four transformation strategies. The authors argue that international governance institutions can, in theory, perform five governance functions. They can provide **guidance & signal** through setting ambitious targets that demonstrate the resolve of treaty members or Parties; establish common **rules & standards** such as coordinated or even integrating national policies or setting common definitions (e.g. for green materials); create **transparency & accountability** to build trust and support compliance of set rules and standards; provide **means of implementation** in terms of capacity building, technology transfer and financial support, especially for developing countries; and facilitate creation of **knowledge & learning** e.g. through coordinated research and development activities.

Finally, we discuss the proposed contours of a plastics climate club vis-à-vis the current political ramifications, in particular the ongoing negotiations of the global plastic pollution treaty.

[1] Technically, decarbonization of plastics is an oxymoron since plastics are typically carbon-based polymers. However, we use the term "decarbonization" in line with the wider academic literature referring to the elimination of carbon emissions along the entire plastic product life cycle.

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Strategies for climate transformation in the plastic sector

There is no clear and dominant techno-economic pathway available that could plausibly describe the transformation of the plastics industry (Bashmakov et al., 2022). The only thing that is clear is that no single strategy alone can achieve climate neutrality in the sector, but rather a combination of all four strategies introduced above is required (Bachmann et al., 2023; Zheng & Suh, 2019). Figure 1 below provides a schematic illustration of the plastic lifecycle and how the four strategies affect it.

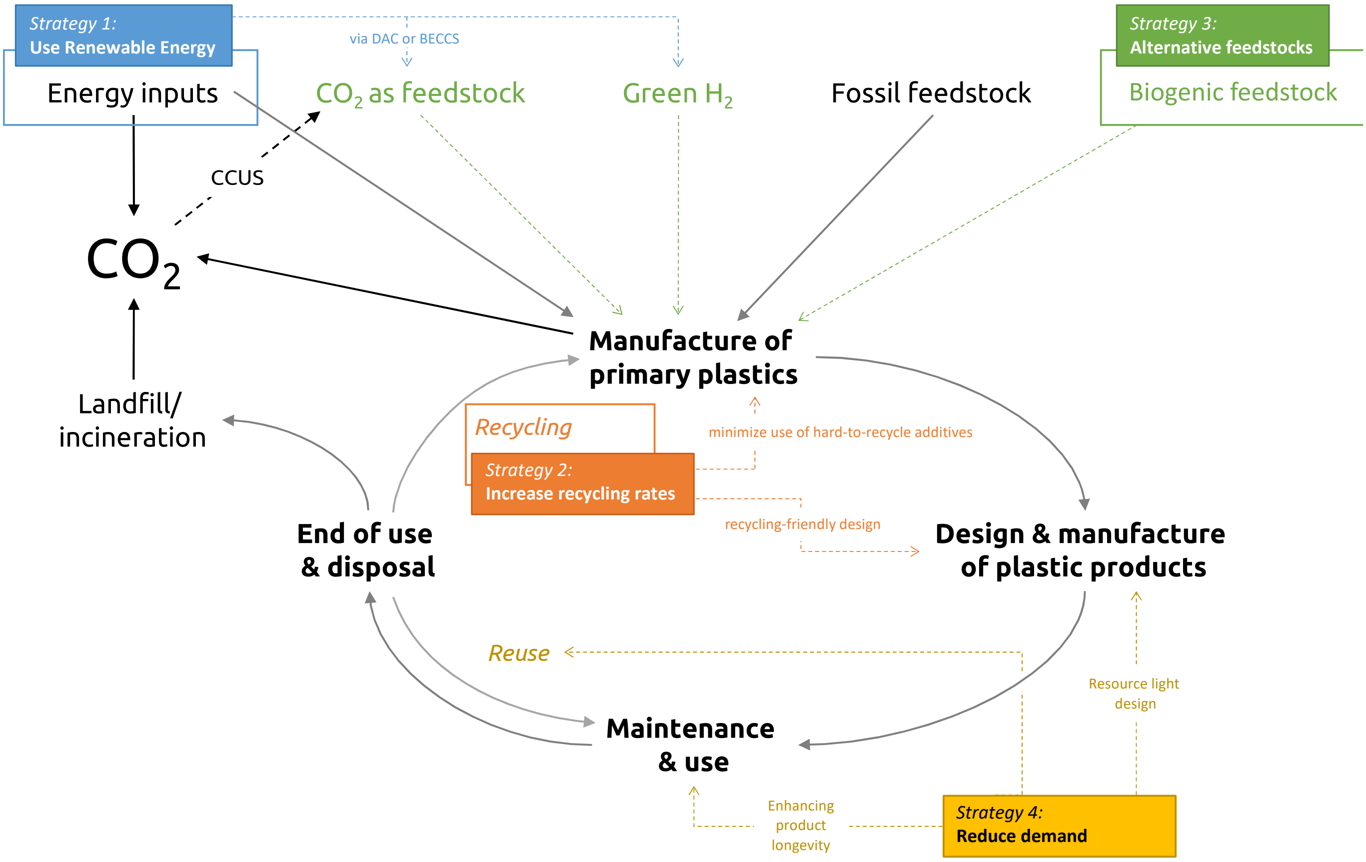

Figure 1: The plastic lifecycle and four key strategies for decarbonization.

The four strategies differ in their structure in that the first three focus primarily on technological solutions while the fourth one is not. Historically, the plastic industry has emphasized technological fixes to fend off demand reductions as this would essentially erase any prospects of growth for the industry as a whole and potentially undermine the industry's social license to operate (Tilsted et al., 2023). However, the scientific literature is clear in that we cannot forego any of those strategies completely (Bachmann et al., 2023; Zheng & Suh, 2019). Their relative importance, interplay, potential trade-offs and synergies remain unclear. Also, the interplay between those strategies can be regionally differentiated (cf. Rootzén et al., 2023). Moreover, optimizing the plastic industry to minimise climate impacts may exacerbate adverse environmental effects on other variables such as biodiversity,

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ocean acidification and the nitrogen and phosphorous cycle (Bachmann et al., 2023).

It is probably impossible to solve the problem of an optimal mix of strategies by design. Given the extremely short timeframe remaining for a timely transformation, a learning-by-doing approach is required combined with constant monitoring of synergies and trade-offs and political reflection in order to be able to correct course if needed. The learning-by-doing relates both to the industry and the technologies and practices they employ as well as to policy instruments supporting them.

Renewable energy inputs

Plastic production requires large amounts of heat. To date, this energy is mostly supplied in the form of oil, gas and also coal (Bashmakov et al., 2022; Cabernard et al., 2022). Electrifying heat supply can already achieve significant emission reductions (Bauer, Tilsted, Pfister, et al., 2023; Madeddu et al., 2020).

Traditionally, in the petrochemical industry, olefins like ethylene are generated through the thermal cracking of lengthy hydrocarbon chains, typically derived from naphtha, using a process known as steam cracking (Herbst et al., 2021). Electric steam crackers are currently under development. This method reduces CO_2 emissions by avoiding the use of fossil energy sources and utilizing low-carbon electricity instead, but it still relies on fossil feedstock and does not eliminate CO_2 emissions at the end of the product life cycle (Herbst et al., 2021; Layritz et al., 2021).

An alternative approach involves utilizing hydrogen as a primary resource. This is accomplished through an intermediate process called methanol-to-olefins (MtO), which involves the initial production of methanol from hydrogen and carbon dioxide in a carbon-neutral manner. While this option can also be described under the category of alternative feedstocks, we decided to include it here due to the vast amount of renewable energy required to produce low-carbon hydrogen and CO_2 derived from direct air capture or other industrial facilities with carbon capture technology (e.g., cement industry). Following this, methanol undergoes further processing in a synthesis facility to yield ethylene and other olefins (see also Meys et al., 2021).

It is important to note that the overall energy demand for producing hydrogen-based ethylene via the methanol-to-olefins pathway is notably higher than the conventional steam cracking method. This requires significant quantities of carbon-neutral hydrogen. While the technology for deriving olefins from methanol is technically advanced, its economic feasibility has not yet been fully realized.[2] Transitioning the production of methanol and olefins to rely on green hydrogen will entail substantial amounts of carbon dioxide as a fundamental input to the process. This integration of carbon dioxide as a feedstock offers the petrochemical sector the opportunity to implement carbon capture and utilization (CCU) cycles, as described in Herbst et al. (2021), even creating market opportunities for CO_2 as a "product". Technically, however, using captured CO_2 from other industrial processes does not avoid but only delay emissions since due to imperfect recycling the resulting plastic materials will inevitably be released in the atmosphere or biosphere.

Increasing recycling rates

The recycling of plastics can substitute fossil fuel based virgin plastics (Zheng & Suh, 2019). To achieve this, enhancing both the quantity of recycling (recycling rates) and the quality of recycling is required as otherwise

[2] MtO has been commercialized as part of the coal-to-olefins production process (Liu et al., 2021), but not with green hydrogen as a feedstock.

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recycled materials deteriorate with each cycle until they eventually can no longer be used as a material (Meys et al., 2021). Clearly, collecting plastics for waste incineration is not conducive to achieving climate neutrality in the sector (Hogg, 2023).

When talking about recycling, it is useful to distinguish two processes. The most commonly established one is mechanical recycling. It involves physically sorting waste by polymer type and processing it into recycled pellets suitable for established applications. The potential for mechanical recycling is limited by plastic type and potential contamination issues. The issue of deteriorating material qualities is particularly relevant for mechanical recycling. Chemical recycling involves breaking down plastics into their molecular components, enabling a wider range of plastic types to be recycled. While chemical recycling offers flexibility and higher recycling rates, it requires large amounts of energy, is currently often associated with large GHG emissions, and under current political and economic circumstances not yet financially viable. Consequently, technologies for chemical recycling at scale are not yet commercially available (Bashmakov et al., 2022).

One major challenge to effective plastics recycling is the presence of certain additives in plastic materials (Raubenheimer & Urho, 2022; UNEP, 2022a). These chemicals can impede recycling processes and compromise the safety and quality of recycled materials. To overcome this challenge, it is imperative to phase out harmful additives from the production and manufacturing of plastics and optimise the use of those additives that hinder effective recycling. This could be achieved e.g., through enhanced transparency or by prohibiting certain particularly problematic combinations of additives.

In addition to constraints due to chemicals, specific plastic applications and products, such as multi-layered composite plastic materials and microbeads present unique difficulties in the recycling process (Raubenheimer & Urho, 2022). Transparency in product information is also critical for achieving circularity in recycling of plastics (UNEP, 2022a). Identifying the polymer type and chemical contaminants in plastic products remains a significant challenge, particularly for low-income countries that are often net-importers of these products. An illustrative instance of promoting transparency is the implementation of "Digital Product Passports." To further support the transition to a circular and low-carbon economy for plastics, it is essential to strengthen waste management facilities, which are currently inadequate and informally organised in many regions (Stegmann et al., 2022).

Alternative feedstocks

Apart from recycled plastics, fossil fuels can also be replaced as a feedstock from alternative raw materials including bio-based feedstocks, such as corn and sugarcane. This would also eliminate end-of-life emissions in case plastic waste is eventually incinerated (Stegmann et al., 2022; Zheng & Suh, 2019). Bio-based plastic substitutes already exist for nearly every conventional plastic type and there is a vast technical potential for substituting of conventional polymers (Zheng & Suh, 2019). But due to the increased use of bioenergy resource, this strategy has significant implications for land use (Meys et al., 2021) which may compromise the carbon benefits associated with bio-based plastics (Bachmann et al., 2023).

Regardless of whether the feedstock is fossil fuels or plants, the conversion of ethylene to polymers such as polyethylene (PE), polyethylene terephthalate (PET) remains the same process, resulting in similar emission values for the conversion process compared to fossil fuel-based counterparts. The manufacturing technologies for converting bio-based and conventional plastics into final products do not differ significantly (Zheng & Suh, 2019).

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End-of-life treatments for bio-PE and bio-PET, including recycling, incineration, and landfill, are no different from those of fossil fuel-based plastics. In contrast, the end-of-life management methods for biodegradable plastics such as polylactic acid (PLA), polyhydroxyalkanoate (PHAs), and thermoplastic starch (TPS) can include recycling, incineration, landfill, industrial composting, or anaerobic digestion. In scenarios aiming for a climate-neutral plastic sector, it is envisioned that recycled bio-plastics will replace virgin bio-plastics whenever feasible (Zheng & Suh, 2019).

Reducing demand

Lastly, demand management refers to strategies reducing the annual growth rate of resin production (Zheng & Suh, 2019). This strategy is complementary to achieving plastic recycling, as the existing waste feedstock alone cannot meet the projected increase in plastic demand (Stegmann et al., 2022). Currently, global demand for plastics is expected to grow with at least 3.5% annually effectively doubling current production by 2035 (Bashmakov et al., 2022). Bachmann et al. (2023) find that, given this massive growth, it is impossible to achieve long-term sustainability (2050) within planetary boundaries for the plastics industry even when all other mitigation strategies are implemented to the fullest possible extent.

Behavioural, lifestyle and societal changes could curb the rapid growth in plastic demand and perhaps even reduce demand in absolute terms (Stegmann et al., 2022). For instance, repairability of products needs to be considered already at the product design stage. Packaging can be also reduced by utilizing reusable plastic products, for example of containers and bottles in service delivery. However, reducing plastic demand should not be pursued at all cost. In many cases, plastics can be a better option compared to even more energy and carbon-intensive alternatives. For example, in the automotive industry, light-weight plastic materials can reduce the demand for glass or metal leading not only to reduced embedded emissions in the product, but also lower emissions and/or energy consumption over the product's lifetime.

Global governance landscape for the plastic sector

Governance involves directing and influencing actions and behaviours by establishing rules, standards, guidelines, or providing targeted support such as capacity-building, technical assistance, or financial aid, all aimed at achieving a specific public objective (Hermwille, 2021). In the global context, governance is commonly established and upheld by institutions such as international regimes, international organisations, and transnational institutions and networks which may include non-state actors.

In our assessment of the global environmental governance landscape for the plastics industry (see Supplementary Table 1 for an overview of the surveyed institutions) allowed us to identify three types of institutions governing (1) the use and handling of harmful substances, (2) addressing end-of-life safe disposal of substances, and (3) overarching institutions that cover the plastics as part of a much wider general mandate such as the G7/G20, the United Nations Framework Convention on Climate Change (UNFCCC) with its Paris Agreement and the Agenda 2030 for Sustainable Development with the Sustainable Development Goals (SDGs).

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The first group of institutions and agreements includes the Stockholm Convention on persistent organic pollutants, the Montreal Protocol on ozone depleting substances, the Minamata Convention on mercury and its components, and the Rotterdam Convention on international trade of hazardous chemicals. These institutions are relevant for the transformation of the plastic industry in that they may govern some of the additives that impede effective high-quality plastic recycling.

Institutions governing safe disposal of substances include notably the Basel Convention on (hazardous) waste and its transboundary movement, the MARPOL Convention on marine pollution with its annex V which prohibits discharge of garbage at sea, the London Convention and London Protocol safeguarding the marine environment against pollution, and United Nations Convention on the Law of the Sea (UNCLOS) which mandates to prevent, reduce and control maritime pollution. Since all of these institutions govern the waste sector, they are relevant again for improved recycling, albeit only indirectly.

Finally, the last category includes the institutions listed above as well as the Convention of Biodiversity (CBD), UNCTAD, ISO and the WTO. The Paris Agreement provides an overarching signal towards decarbonization, but does not contain any sector-specific provisions (Otto & Oberthür, 2022). Notably, the Agreement does not expressly address the phase-out of fossil fuels. At the recent COP27, Parties debated whether to include a reference to "phasing down all fossil fuels" but this was ultimately not adopted (Obergassel et al., 2022). In theory, it could address all four strategies, but it does so only tangentially.

Similarly, the SDGs create an overarching governance framework with little immediate effect. Particularly relevant for the first three strategies are SDG 9.4 on upgrading industrial production and the supporting infrastructure towards sustainable production, and SDG 9.5 on enhanced research and innovation for sustainable industrial production. SDG 12 on sustainable consumption and production is particularly relevant for the alternative feedstocks strategy (SDG 12.3) and enhanced recycling (SDG 12.4) and even demand reductions (SDG 12.5). While the SDGs may set relatively concrete targets for the plastics industry, they lack the other governance functions as well as a dedicated arm for implementation. Moreover, the recent progress report on SDG implementation states that implementation of SDGs 9 and 12 is falling short. However, detailed assessments of the corresponding targets is not provided (UN, 2023).

The G7/G20 are relevant particularly for the increasing renewable energy and alternative feedstocks strategies. In particular the 2009 commitment of the G20 to phase out inefficient fossil fuel subsidies is noteworthy. However, this commitment remains an empty promise so far with a new record high in fossil fuel subsidies in 2022 (IMF, 2023).

Finally, there are some more specific initiatives with relevance for the sector. The Beyond Oil and Gas Alliance (BOGA) is an international coalition focused on phasing out oil and gas production. Core members commit to ending new concessions, licensing, and setting Paris-aligned dates to cease oil and gas production (Bauer, Tilsted, Deere Birkbeck, et al., 2023). The Industrial Deep Decarbonisation Initiative (IDDI) aims to increase demand for low-carbon industrial materials. It focuses on energy-intensive sectors like steel, cement, and concrete, while also considering potential initiatives in other industries (Bauer, Tilsted, Deere Birkbeck, et al., 2023). The recently established WTO Dialogue on Plastics Pollution engages 76 members to explore how trade cooperation can support efforts to address plastic pollution (Bauer, Tilsted, Deere Birkbeck, et al., 2023). This dialogue focuses on cross-cutting issues,

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promoting trade in sustainable waste management technologies, alternatives to plastics, and enhancing circularity (Raubenheimer & Urho, 2022).

One initiative that is not yet a proper international institution but seeks to establish one is the Fossil Fuel Non-proliferation Treaty initiative. Its aim is to establish a legally binding international agreement to phase out fossil fuel production, ensure a just transition, and hold governments accountable (van Asselt & Newell, 2022). While the initiative has received increasing attention in civil society and academic circles, it still remains a relatively marginal theme in international diplomacy.

In March 2022, the UN Environment Assembly adopted resolution 5/14 that mandated the negotiation of a "legally binding instrument on plastic pollution (...) based on a comprehensive approach that addresses the full life cycle of plastic, …" (UNEP, 2022b, para. 3). The resolution laid the foundation for the establishment of a negotiating body dedicated to the plastic pollution treaty, known as the International Negotiating Committee (INC). Given its mandate, the negotiations primarily focus on addressing plastic pollution in the sense of leakage or littering in nature especially in the marine environment, and builds upon the existing governance framework for tackling this issue.

Treaty negotiations do not explicitly include discussions on greenhouse gas emissions in the plastic sector, but some actors have advocated the interlinkages between the two issues. Our analysis of the numerous propositions from parties and stakeholders shows that the plastic pollution treaty may potentially be relevant for three of the four decarbonization strategies: increasing recycling rates, utilising alternative feedstocks, and limiting demand for plastic and plastic products (Tilsted et al., 2023; UNEP, 2023a). Yet, one aspect that has not been extensively discussed in the plastic treaty negotiations is the decarbonization of energy inputs in the plastic sector through the use of renewable energy instead of fossil fuels. Achieving full decarbonization is impossible without tackling energy inputs since they contribute at least 51% of the industry's total greenhouse gas emissions (Zheng & Suh, 2019).

Our analysis shows that there is increasing attention to plastics in global governance, albeit with limited focus on climate change mitigation. Existing international regimes rarely address the sector decarbonization directly. There is a lack of institutions and initiatives addressing the substitution of equipment for less emission-intensive plastic manufacturing processes and the replacement of fossil fuels with renewable energy inputs. Recycling is the most affected strategy, but it is only addressed indirectly by institutions focusing on safe chemicals (some of which may impede recycling) or safe handling and disposal of waste. Some initiatives are exploring alternative feedstocks for plastic production. There is an absence of strategies aimed at reducing demand for plastic altogether. The plastic treaty holds promise in indirectly supporting climate change mitigation in the plastic sector by pushing recycling rates, promoting alternative low-carbon feedstock, and addressing the reduction in plastic demand. However, it falls outside the treaty's scope to tackle the transition towards less emission-intensive fuels and equipment for plastic manufacturing.

Can a plastic climate club close the governance gap?

The above analysis indicates that significant governance gaps remain. The plastic pollution treaty may address some of those gaps. However, the mandate of the treaty negotiations is on plastic pollution and not decarbonization.

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Within the negotiations it has yet to be defined what a pollutant is and specifically whether GHG emissions should be considered one. Climate change mitigation clearly is not the primary objective of the negotiations and depending on the question of which pollutants ought to be included, may end up as a side effect, at best.

But is a climate club the right tool for the job? It has been argued that a club approach might be particularly useful in cases where a relatively small number of actors companies and countries contribute a major share of global production and these products are particularly trade-exposed with high risk of carbon leakage which might create a relatively strong incentives for the affected actors to join the club. Both of these conditions are met in the plastic industry. The market for basic thermoplastic raw materials is relatively concentrated, with relatively few producer countries and companies. The EU, North America and China combined contribute nearly two thirds of global production (Plastics Europe, 2022). Moreover, plastic is a globally traded commodity in the form of plastic items, pellets, (semi-)processed parts, as well as post-consumer waste (Dauvergne, 2018). Since all options to substantially reduce CO_2 emissions from the plastic industry involve technologies associated with elevated capital and operational expenditures, measures to mitigate trade exposure and losing market shares from elevated prices are required in order to give producers confidence to invest in sustainable production and facilitate decarbonization of the sector (Woodall et al., 2022). Consequently, we argue that a club approach that is narrow in participation but deep in engagement with the sector might be a promising way forward. Of course, a condition for success would be to have a critical mass of countries and companies covering a relevant share of global production capacities on board. This would include at least the EU, the United States and prospectively also China and other major Asian producers.

In the remainder of this section, we highlight potential activities of a global plastic climate club. We do so by referring to the governance functions framework proposed by Oberthür et al. (2021). Note that not all of the proposed elements necessarily need to be part of the plastic climate club. Some of them might be more suitably included e.g., in the plastic pollution treaty but the club might be a fallback option if this cannot be achieved. We will discuss some of these aspects in the subsequent section.

Guidance & signal

This governance function would be mostly fulfilled by the club's overarching goals and objectives. On the most generic level, a goal to **achieve climate neutrality in line with the objectives of the Paris Agreement (e.g., in year 2050)** could be a first option. However, in order to unfold its full potential, it would be useful to operationalize the goal further and complement it with more specific and more near-term goals.

Irrespective of the eventual technological landscape that may arise, conventional steam crackers have no place in a plastic sector striving for climate neutrality. Thus, to establish additional objectives, the club could reach a **consensus on the gradual phase out of unabated conventional steam crackers**.[3] A phase-out of coal as a feedstock in the chemical industry should also be considered as this is a particularly carbon-intensive practice.

[3] The proposed goal is formulated purposefully ambiguous. There are several options that could still be possible ranging from renewably powered electrical steam crackers to conventional steam crackers with carbon capture technology. For the latter, different capture rates could be required. A more detailed discussion of the merits of each approach is beyond the scope of this paper.

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Further objectives might encompass the gradual decrease in fossil fuel-derived virgin plastic, the expansion of bio-plastics, and the promotion of recycled plastics sourced from both previously plastic-based materials and bio-plastics. A climate club could also set specific targets for the reduction, reuse, and repair of plastic products.

In a recent paper Bachmann et al. (2023) assess what it would take to bring the global plastic industry in line with the planetary boundaries. According to their analysis recycling rates need to achieve 75% in 2030 and the theoretical maximum of 94% in 2050. But even then, additional demand reduction is required to stay within planetary boundaries. Beyond that study, there is very little academic research as to the exact values at which such targets should be set. Moreover, in practice, target setting is more of a political exercise than a precise science. Targets emerge from multilateral negotiations and rarely follow directly from the best available science.

Rules & standards for collective action

A concrete operationalization of the proposed phase out of conventional steam crackers, would be to adopt an **investment moratorium** among the club members, potentially with differentiated timelines to address common but differentiated responsibilities and capabilities of developed and developing countries.

As Skovgaard et al. (2023) show, public funding from developed countries including through export credits are still a major pillar for financing new production facilities. A clear minimum could be to agree to **stop public funding of new conventional unabated production facilities**. Since much of the private finance for new production facilities also originates from the Global North, financial regulations inhibiting this kind of lending might also worth pursuing. (cf. Skovgaard et al., 2023).

A third element could be to adopt common **definitions for green basic chemicals/plastics** and establish a labelling and certification scheme (see also Birkbeck et al., 2023). This could draw on existing instruments such as the EU taxonomy or the basic chemicals criteria of the Climate Bonds Initiative (Climate Bonds Initiative, 2023). Such a definition would be prerequisite for the creation of green **lead markets** leveraging private and public demand for green plastics and enabling premium prices to reduce uncertainty for investors. Under the Industrial Deep Decarbonization Initiative (IDDI) several countries have already pledged to use **public procurement** for green steel and cement. This could also be extended to cover plastics and plastic products. When adopting common definitions for the most ubiquitous polymers, it is important to avoid favouring national circumstances, as this could lead to protectionist tendencies and consequently diminishes competition. The desired outcome of competition between foreign and domestic companies is the reduction of prices and forces companies to minimise their costs as much as possible.

If not already adequately covered by the plastic pollution treaty, a climate club could also address two aspects that currently impede more effective recycling of plastic waste: the use of additives and the proliferation of ever more different variants of different plastics (Dauvergne, 2018). In relation to additives, club members could adopt a **ban on certain additives or strict guidelines and limitations for their use**. For the latter, concrete incentives to prioritise the most commonly used and most easily recyclable plastic "staples" are required. One way to address this would be trade barriers. For instance, club members could agree on a limited **white list and reduce trade tariffs and duties**

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on selected staple plastics and/or biobased and recycled plastics.[4] This would improve the terms of trade of those staple plastics over other specialty plastics thus providing a disincentive to introduce ever more plastic variants without limiting flexibility to develop specialty plastics for very specific use cases. Furthermore, club members could agree to work to remove barriers that still hinder the circularity of plastic materials, for example, complex rules for high-quality recycling plastic imports, which limits the use of recycled plastic packaging or slow regulatory approval process regarding the use of recycled plastic products.

Some prominent authors see the coordination and harmonisation of carbon pricing policies as the main *raison d'etre* of a climate club (Hovi et al., 2019; Nordhaus, 2015). While more effective carbon pricing may have an effect on the energy inputs of the plastics industry, its effect is expected to be limited when it comes to incentivising circularity (Meys et al., 2021). We therefore deem that a plastic climate club should not serve as platform for deliberating carbon pricing policies as a matter of priority.

Transparency and accountability

Currently, there is a dearth of information publicly available on the exact production of main plastic commodities in relation to the type, volumes, origins and associated emissions. However, a clear understanding of the nature and scale of the challenge is a prerequisite for adopting common rules and standards in the first place. So, **establishing a monitoring, reporting and verification framework for the plastic industry** could be a major design element of a climate club. Such an aggregated reporting framework could also be complemented by **standardised methods for calculating the CO_2 footprint** of commodities, specifically focusing on plastic products in this instance. If not agreed within the plastic treaty, the climate club could function as a platform for the creation of a **digital product passport**, enabling the identification of polymer types and chemical contaminants. This initiative could be achieved by designing a globally standardised system for accessing essential information about product content, utilising the benefits of contemporary digital tools.

Means of implementation

Successfully implementing the decarbonization of the plastics industry will require a large amount of human and technological capacities as well as substantial financial means to leverage investments and cover higher capital and operational costs of green polymers over their conventional counterparts.

The climate club should address all three of these aspects. **A capacity building programme could for example focus on building recycling infrastructure and/or maintaining infrastructure for digital product passports.** As described above, many key technologies – e.g., electric steam crackers or technologies for chemical recycling – are not yet commercially available. As soon as they become available, they need to be deployed at an extraordinary pace to meet the ambitious timeline imposed by the well below 2°C target – and even more for the 1.5°C goal as set out in the Paris Agreement. Dedicated programmes could support this, e.g., through a **technology fund** that can (partially) cover licence fees or other appropriate instruments. Such a fund could rely on voluntary contributions by member

[4] If club members agree to reduce tariff only for trade among themselves, this might be perceived as a violation of the most-favoured-nation principle of the Global Agreement on Tariffs and Trade (GATT) which stipulates that countries cannot discriminate between their trading partners. Alternatively, club members could also agree to reduce tariffs unilaterally irrespective of the trade partner's club membership thus avoiding the violation of the principle.

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states initially or through more innovative funding mechanisms including fees and duties on selected plastic products (see below).

In any case, capacity building initiatives should be tailored to individual countries, aligning with their unique priorities and specific national circumstances and should encompasses various strategies, including the advancement of environmentally sustainable technologies, the dissemination of best practices, the establishment of clear and ambitious guidelines and standards, which are crucial for attaining climate neutrality within specific sectors. This could, for example, entail capacity building for workers with respect to waste sorting and recycling strategies.

Finally, financial means of implementation will be required to support developing countries with the implementation of policies and measures to decarbonize the plastic sector. Drawing on voluntary climate finance contributions from developed countries has proved to be problematic due to the inadequate overall volume as well as the predictability of the funding.

Ideally, innovative funding mechanisms should be established that generate a source of funding that is reliable and independent from political tides in donor countries. One idea would be to **earmark revenues from trade measures** discussed above. Another option would be to establish a **packaging and single-use plastics fund.** Operationalizing the principle of extended producer responsibilities, all producers and importers of packaging and single-use plastics[5] would be required to pay a surcharge into the fund. The revenue would, in turn, be used to pay recycling companies or other activities of the club such as the technology fund proposed above.

The scheme could be differentiated both on the income and the expenses side. On the income side, the fund could differentiate the surcharge for different types of plastics, e.g., requiring a much higher premium for non-recyclable and carbon-intensive plastics and plastic products including composite materials. This could also help to shape the incentive structure towards less variation in the use of plastics. On the expenses side, the pay-outs could be differentiated by the type of recycling (mechanical vs. chemical) or by country, e.g., paying a higher premium in countries with no or only nascent recycling industries.

Such a fund would also create a real excludable club good: the surcharge would be levied also on all imports from non-members, but the pay-outs would be limited to companies operating within the club. This could be a strong incentive for developing countries to join the climate club, allowing them to benefit from this funding while simultaneously addressing the plastic pollution crisis within their own territories by improving their capacities to manage the plastic waste.

Knowledge and learning

As discussed in above, A successful transformation of the plastic industry will require learning by doing. But the learning does not happen automatically. The club members could adopt joint research and development activities to advance key technologies enabling the transformation and eventually to share such successful designs and approaches. Moreover, a climate club could set up an organisational structure to **survey key technological innovations** beyond its own R&D activities thus facilitating accelerated technological learning in all relevant areas.

[5] In some existing schemes the onus of EPR is not on the producers of packaging but on companies that bring packaged products to the market.

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This also applies to policy instruments. There exists a gap in the monitoring of the efficiency of national policies governing plastics (March et al., 2022). The climate club could function as a platform for **systematic mapping and evaluation of policy instruments** promoting the decarbonization of the plastic industry covering aspects such as integrating renewable energy sources, enhancing recycling processes, exploring alternative raw materials, and curbing demand for plastics. Effectively, this could enable the plastics climate club to become a **policy learning accelerator** (Schepelmann & Fischedick, 2020).

Discussion

One major remaining question is which of these options could be realised in the form of a plastic climate club. It can be expected that some of the options may be implemented at least in part under the new plastic pollution treaty. Others might be better placed in other existing environmental agreements. In this dynamic environment, a key question is therefore how a plastic climate club would position itself vis-a-vis the existing institutions and in particular vis-a-vis the plastic pollution treaty. Any plastic club initiative that would position itself in competition to the ongoing treaty negotiations would risk derailing the diplomatic process. Parties not involved in the club process would strongly oppose the club and decry that the club would pre-empt the results of the more inclusive discussions of the plastic pollution treaty. So, any Party that is interested in a strong plastic pollution treaty would have to be extremely careful to position the climate club as a complementary and not a competing instrument.

Fortunately, our analysis provides several meaningful vantage points for just that. First of all, the ongoing treaty negotiations cover aspects related to three of the four key decarbonization strategies: increased recycling, alternative feedstocks, and reduced demand. However, the fourth one – using renewable energy inputs – is not covered. So, this area would be a natural starting point for a plastics climate club. In its initial phase the plastic club could therefore prioritize goal-setting. It should adopt commitment to phase out unabated fossil fuels in (primary) plastic production and a moratorium on new investments in conventional steam crackers. Moreover, dedicated R&D activities and knowledge brokering activities to support the uptake of renewable and low carbon energy in the sector could be a focus.

That is not to say that the other decarbonization strategies need to lie bare for the duration of the treaty negotiations. Instead, the plastic club could act as a bargaining club (Falkner, et al., 2022) and form a negotiation alliance with the objective to achieve an ambitious plastic pollution treaty not only in its core objective to reduce pollution but also with respect to climate change mitigation side effects. Embedding such a bargaining alliance inside a formal climate club could also strengthen the negotiation position of the club members as they would be able to credibly argue that they revert to regulating within the club those aspects that are insufficiently addressed in the plastic pollution treaty. The club would effectively become a backstop for the treaty negotiations.

In addition to the Plastic Treaty, it is important to highlight the significance of key agreements like the Basel Convention, Rotterdam Convention, and Minamata Convention for recycling plastics. These conventions already offer a foundation for addressing chemicals that pose obstacles to recycling, albeit with certain gaps. Rather than establishing redundant frameworks in this regard, the club should focus on closely coordinating its efforts with

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these existing platforms. For example, harmful additives might be most adequately addressed under the Basel Convention, but if agreement on this is not possible, the climate club could again become a fallback option.

Specifically, the Climate Club established at the G7 meeting in Germany could provide a forum to develop more concrete governance arrangements for the plastic industry. The club has an express objective of supporting industrial transformation. However, as it currently stands it is set up as a multilateral forum and lacks the institutional rigidity to implement many if not most of the design options proposed above (G7, 2022). However, the club could well serve as an umbrella for developing more concrete and more binding governance arrangements.

Conclusions

Our analysis yields three major results: First, meeting the Paris objectives requires a fundamental transformation of the global plastic industry against strong opposition from the fossil fuel industry which is trying to defend its last resort of economic growth. That transformation is particularly challenging because no clear decarbonization pathway exists. Four strategies have been identified to guide the plastic sector towards climate neutrality. These strategies include utilizing renewable and low-carbon energy sources for production, adopting alternative feedstocks, increasing recycling efforts, and reducing demand for plastic products.

However, when assessing the global governance landscape for these strategies, it becomes evident that there are significant gaps. Notably, the use of alternative feedstocks and increased recycling are partially addressed, though still insufficiently, in existing initiatives and frameworks. The reduction of demand for plastic products and the use of low-carbon energy carriers are hardly addressed at all. In short, our second result is that the existing global environmental governance landscape is insufficient to create the required enabling environment for the transformation of the plastic sector. It does not reset expectations for investors, nor does it provide tangible regulation to accelerate decarbonization and circularity, nor does it provide in a meaningful way means of implementation.

Building on this, our third result is a series of governance options that could help to foster said enabling environment:

- Ambitious long-term and interim policy targets are required to set expectations of investors and policy makers at national and subnational level.
- These targets could be substantiated through concrete rules and standards such as a moratorium on investments and public funding in new conventional fossil-based and unabated production facilities, or common definitions for green polymers to enable the creation of lead markets, e.g., via public procurement. Preferential tariffs for selected staple plastics could set incentives to focus on more easily recyclable polymers instead of creating ever more specialty plastic variants.
- A systematic monitoring, reporting and verification framework is required to close the information gap that still hampers more ambitious international cooperation.

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- Means of implementation are required to implement the transformation. This relates to human capacity, technologies and, crucially, financial means. A packaging and single-use plastics fund could be established with a surcharge on all producers and importers of corresponding plastic products and the revenues used to finance more effective recycling.
- Systematic R&D and knowledge brokering would help to accelerate technological and policy learning which is essential in a transformation that can only succeed in a learning-by-doing mode.

Overall, we conclude that a plastic climate club is a promising strategic instrument to foster the transformation of the global plastic industry. There is sufficient room to manoeuvre in the global governance landscape to start an initiative immediately. There is no need to wait for the conclusion of the negotiations of the plastic pollution treaty. Instead, a climate club could become a major driver for ambition within the negotiations.

Unfortunately, a detailed tactical question of how to go about forming such a climate club is beyond the scope of this paper. Natural starting points could be existing informal alliances within the plastic pollution treaty negotiations or the so-called High Ambition Coalition that was instrumental in the final hours of the negotiations of the Paris Agreement. Alternatively, the climate club adopted by the G7 in 2022 has the express goal of supporting industrial transformations and could become an umbrella for hosting negotiations on a more specific plastic climate club. However, a more substantive analysis of who could lead such an initiative, who would have to be on board to create a stable core membership group, and many other operational questions require additional research.

We still hope that this contribution provides a first step to advance both the academic and political discussion to break the gridlock of transforming the plastic industry towards a sustainable and low-carbon future.

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Supplementary Table 1: Overview of institutions and initiatives and their relevance for decarbonizing the plastic industry. ***Source: own compilation on the basis of Raubenheimer & Urho*** **(2022)** ***and Bauer et al.*** **(2023).**

Multilateral environmental agreements and other international initiatives	Description	Renewable energy inputs	Increasing Recycling Rates	Alternative Feedstock	Demand reduction
Stockholm Convention	On persistent organic pollutants (POPs). Prohibits and/or restricts the use of listed POPs, some of which are used, among other as additives in plastics.		X		
Montreal Protocol	On ozone. Prohibits the use of certain substances incl. their use of blowing agents in the production of extruded polystyrene and polyurethane foams. Exemptions as process agents and feedstocks; restriction in manufacturing of products.		X		
Minamata Convention	On mercury and mercury components in general. Production of polyurethane as catalysts and in vinyl chloride monomer products		X		
ILO Chemicals Convention, 1990 (No. 170)	Issues work safety rules for employers in sectors where employees are exposed to chemicals. Relevant for chemicals and processing aids used for plastics.		X		
Rotterdam Convention	On international trade of hazardous chemicals. Mandates prior informed consent (PIC) procedure in international trade of chemicals some of which are used among other, as monomers, additives, or processing aids in the production of certain plastics.				
SAICM	Aiming for a sound management of chemicals throughout their life cycle.		X		
Basel Convention	On hazardous waste and other waste and their transboundary movement. Guidance on the technical requirement for the environmentally sound management of plastic waste. Defines three groups for plastic waste, two need consent before shipment; prohibits the export of hazardous waste from members to all other countries.		X	X	X
MARPOL Annex V	Prohibits the discharge of garbage into the sea. Plastic is included in the definition of garbage (e.g., synthetic fishing nets).		X		
London Convention	The aim is to safeguard the marine environment against various forms of pollution. This involves prohibiting the global disposal of land-originating waste containing plastics, as well as the incineration of plastics on maritime waters.		X		
London Protocol	Builds on the London Convention. Prohibits the global disposal of waste originating from land unless exempted within the protocol's provisions. Excludes plastics and chemicals utilized in plastic production from allowable waste.		X		
UNCLOS	Participating states are mandated to protect and preserve the marine environment (prevent, reduce and control pollution, including plastics).		X		

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Multilateral environmental agreements and other international initiatives	Description	Renewable energy inputs	Increasing Recycling Rates	Alternative Feedstock	Demand reduction
CBD	Conservation of biological diversity; requires rehabilitating and restoring degraded ecosystems and promoting the recovery of threatened species (for example polluted by plastics).				
UNFCCC	Stabilization of GHG concentrations in the atmosphere; restrict GHG emissions associated with production of plastics.	X		X	
Paris Agreement	Emission reduction targets as part of nationally determined contributions.	X		X	
Sustainable Development Goals	The SDGs formulate targets for upgrading industry and supporting infrastructures for sustainable production, the sustainable use of natural resources (alternative feedstocks) and reduce, reuse and recycle (plastic) waste.	X	X	X	X
Beyond Oil and Gas Alliance (BOGA)	Is an international coalition focused on phasing out oil and gas production.	X		X	
Industrial Deep Decarbonisation Initiative (IDDI)	Aims to increase demand for low-carbon industrial materials.	X			
G7/G20	Provide political opportunities to address the petrochemicals sector, including plastic pollution and climate change. G20 have also agreed to phase out inefficient fossil fuel subsidies.	X	X	X	
UNCTAD	UNCTAD explores eco-friendly non-plastic alternatives in developing countries.			X	
WTO's Dialogue on Plastics Pollution	The WTO's Plastics Pollution Dialogue involves 76 members, discussing how trade cooperation aids plastic pollution mitigation. It emphasizes cross-cutting concerns, fostering sustainable waste tech trade, plastic alternatives, and circular practices.		X	X	
International Organization for Standardization (ISO)	ISO creates standards for petrochemical processes such as plastics. It operates technical committees and subcommittees for plastics, covering environmental aspects like bio-based plastics, biodegradability, carbon footprint, circular economy, microplastics, and waste management.	X	X	X	

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POLICY PAPER

CONTOURS OF AN INTERNATIONAL PLASTICS CLIMATE CLUB

Corresponding Author

Dr Lukas Hermwille
lukas.hermwille@wupperinst.org

Project Coordination

Wolfgang Obergassel
wolfgang.obergassel@wupperinst.org

PARTICIPANTS

Wuppertal Institut
VUB Brussels School of Governance
IDDRI
DLR Deutsches Zentrum für Luft- und Raumfahrt German Aerospace Center
E3Modelling Energy Economy Environment
bc3 Basque Centre for Climate Change Klima Aldaketa Ikergai Sustainability, that's it!
University of Eastern Finland
IIM Ahmedabad
University of Cape Town
清華大学 Tsinghua University
IPB University Bogor Indonesia
School of Public Policy Center for Global Sustainability
HOLISTIC

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