BRIEFING: FALSE SOLUTIONS TO THE PLASTIC POLLUTION CRISIS

Introduction

The negative environmental and human health impacts of plastic reach dizzying proportions throughout its lifecycle. Plastic production pollutes, from fracking and other fossil-fuel extraction, to petrochemical plants producing plastic feedstocks, to pesticide-fueled intensive agriculture producing bio-based plastic feedstocks, to the use of toxic additives. The toxic effects of plastics persist throughout their consumption, recycling, and disposal.[i]

Many plastics contain toxic additives, which can make up a significant portion of final product mass. These include plasticizers such as phthalates and bisphenols, fluorinated surfactants or PFAS, brominated flame-retardants, and heavy metals, among others. Forms of toxicity include endocrine disruption, specific organ toxicity, as well as developmental, mutagenic, and carcinogenic toxicity. Some of these toxic chemicals also accumulate in living organisms.[ii] The fragmentation of plastics into microplastics and nanoplastics is of particular concern, given that microplastics have entered the food chain, and that nanoplastics have the capacity to pass through biological membranes and affect cell functioning.[iii]

Once plastics are in the environment, they cannot be removed. They simply appear in a different (and often more harmful) form over time - whether through anthropogenic intervention (with incineration or plastic roads and building materials) or through environmental conditions (such as weathering and photodegradation). While plastics already present in the environment must be managed in order to reduce environmental harm, genuine solutions to the plastic pollution crisis must emphasize prevention.

This briefing responds to several proposals to address the plastic pollution crisis, including incineration ("waste to energy", "plastic to fuel"), biodegradable and compostable plastics, plastic recycling without significant reduction, as well as chemical recycling.[iv] Many of these processes pollute the environment, are resource and energy-intensive, expensive, and do not function as closed-loop systems. They are also inadequate because they are end-of-pipe solutions that perpetuate our unsustainable production and consumption of low-grade, non-recyclable plastics.[v]

Enter zero waste: an affordable, energy and resource-efficient system that works in practice, supported by a flourishing number of success stories across the globe. Zero waste is a simple, common-sense yet comprehensive system for a circular economy that hinges first and foremost on waste prevention. It reduces the volume of problematic materials entering the economy by reducing plastic consumption and associated fossil fuel use. In other words, zero waste posits that the most effective solution to the plastic pollution crisis is simply to make less of it.

Incineration (“waste to energy”, “plastic to fuel”, “zero net waste”)

Incineration - including "waste to energy," waste-burning in cement kilns and other industrial boilers, as well as "plastic-to-fuel" processes such as gasification, pyrolysis and plasma arc - fails as an option to sustainably manage waste, or effectively recover resources in a non-toxic way. With its polluting, wasteful and cost-prohibitive nature, waste incineration harms communities and the environment. Deceptively similar to the legitimate term "zero waste," so-called "zero-net-waste" or "zero-waste-to-landfill" waste-management systems may include sending waste to incinerators.

Incineration pollutes the air, water and earth, harming poor and marginalized communities

Incineration converts waste into air pollutants, fly and bottom ash, boiler slag, and wastewater sludge through burning. This process harms human health and the planet by emitting nanoparticles and other respiratory irritants, cancer-causing dioxins and furans, heavy metals including mercury, cadmium and lead. Incineration also emits greenhouse gases that contribute to climate change.

Incinerator pollution-control devices regularly fail, while captured pollutants remain concentrated in by-products such as ash and sludge, which are sent to landfills or used in cement and other building materials, and leach into soil and groundwater. Even the newest incineration systems generate toxic pollution. While often described as an alternative to landfills, incineration is in truth a stage before landfill.

Incinerators are also disproportionately placed in poor communities and socio-politically marginalized communities, burdening them with toxic ash and air pollution, noise pollution and accidents.[vi]

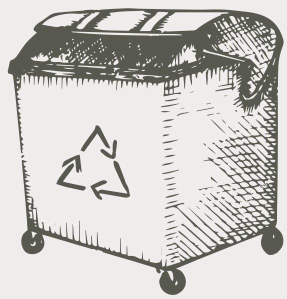
Incineration wastes energy and resources

"Waste-to-energy" incineration (including gasification and pyrolysis) is a misnomer, because it wastes more energy than it produces.[vii] It also perpetuates a wasteful linear economy based on the excessive extraction of natural resources including minerals and fossil fuels. It relies on the endless production of material goods, perpetuates a throw-away culture and capital-intensive infrastructure.

Local government held hostage to expensive incinerator investments

Incineration is also the most expensive way to manage waste and produce energy due to low efficiency of waste and a constant demand in feedstock required to keep the system operational (the "lock-in" effect). It takes investments away from real renewable energy and zero waste solutions.[viii]

ZERO WASTE



VS.

Mitigate climate change

Zero waste practices conserve finite resources and prevent fossil fuel extraction to produce virgin materials. Research shows that adopting waste reduction strategies in the U.S. alone would be comparable to closing 1/5 of the country's coal-fired power plants.

Create jobs & save money

Recycling and composting create 10-20x as many jobs as incinerators, for a fraction of incinerator capital costs.

Improve public health

Waste reduction and recycling help improve overall health by decreasing exposure to hazardous materials and preventing pollutants associated with landfilling and incineration from contaminating the environment.

THE SOLUTION

WASTE BURNING

Worsen climate change

Incinerators emit more carbon dioxide per megawatt-hour than coal-fired power plants.

Hurt recycling

Incinerators burn valuable resources that can be recycled and composted, and incinerators compete for the same materials as recycling programs. Countries in Europe that have high waste incineration rates typically recycle less.

Harm communities

Heavy metals, organic and inorganic pollutants and other toxins realeased by incinerators pose increased risk of cancer, neurological and developmental disorders to humans as well as damage the environment in the neighboring communities and beyond.

THE PROBLEM

Source: Global Alliance for Incinerator Alternatives (GAIA). (2012). Incinerators: Myths vs. Facts about "Waste-to-Energy"

Biodegradable and compostable plastics

The end-of-life behavior of plastics is highly relevant in addressing the plastic pollution crisis. However, the term "bioplastics" covers materials with different composition, different properties and different end-of-life behavior. This section focuses on bioplastics that are biodegradable, regardless of their sourcing (whether they are "bio-based" or not). Non-biodegradable bio-based plastics are covered under the section on recycling (next chapter).

Biodegradable and compostable plastics vs. oxo-degradable plastics

Biodegradable plastics degrade under biological (mainly microbial) action. We'll mostly refer to compostable plastics, which degrade under controlled conditions, such as at an industrial composting or anaerobic digestion site. While compostability is well defined in relevant standards, degradability in the open environment, as sea or lakes, is not fully defined, and may depend on too many factors (exposure to light, waves, temperatures, salt, etc.). This makes biodegradable plastics a totally unsuitable solution to tackle plastic pollution.

Oxo-degradable plastics are fossil fuel-derived plastics with additives that make them fragment into microplastics in the presence of sunlight and oxygen, creating persisting environmental pollution. They are not biodegradable nor recyclable, increase formation of microplastics, and should be banned; the EU has taken the initiative to have them finally banned.[ix]

Simple substitution for single-use undermines reduction

Biodegradable and compostable plastics are often presented as an easy substitute for single-use plastics. This form of substitution involves the continuous production of energy and resource-intensive feedstocks and manufacturing processes in order to generate materials destined to be used once and swiftly discarded.[x] This perpetuates our unsustainable, throw-away culture and linear economy, and wasteful production and packaging practices.[xi]

As such, the substitution of single-use plastics with single-use biodegradable and compostable plastics is not an adequate solution to the plastic pollution crisis. Single-use plastics of all sources must be phased out, and materials must be redesigned for durability and reusability.

Exceptions: compostable plastic bags for separate organics collection and other suitable applications

Compostable plastic bags optimize food scrap collection for composting organics including within local zero-waste programs, by increasing user-friendliness. This maximizes captures, minimizes the presence of organics in residual waste, and makes it possible to remarkably reduce the collection frequency for residual waste. This in turn enables the implementation of pay-as-you-throw, cost optimization of Zero Waste schemes and better separation of other dry recyclables.

Compostable plastics may also be suitable for a limited range of other applications, provided they are tightly connected to separate collection of organics and compost schemes, such as disaster-relief operations where the absence of clean water or other conditions make reuse unsuitable.

Adequate management of compostable plastics requires that compostable plastics are certified with clear labels that correspond to robust standards of composting (and/or anaerobic digestion) in industrial facilities (such as EN 13432, EN 14995, ISO 18606, ASTM D6400).[xii]

These standards require testing for intrinsic biodegradability, limit heavy metals to levels compatible with those of food scraps and garden waste, ensure specific compostability in real composting operations, and protect the quality of the final compost from ecotoxicity.

Pollution and climate change impacts of biodegradable and compostable plastics

The pollution and climate-change impacts of fossil-fuel feedstocks are well-known. Biomass feedstocks from industrial agriculture may be highly problematic, too, due to soil degradation, water scarcity and pollution, biodiversity loss, and climate change impacts. Biomass feedstocks from agricultural or food waste are preferable due to their lighter environmental impact.

As mentioned above, only compostable plastics that adhere to robust international standards for compostability allow adequate end-of-life management in industrial composting facilities.

When biodegradable and compostable plastics are incinerated or landfilled, they contribute to pollution and climate change. In landfills, they degrade without oxygen, releasing methane, a powerful greenhouse gas more harmful than carbon dioxide.

Biodegradable and compostable plastics do not make sense in home-composting where their degradability may be uncertain, hence the need to enforce robust compostability standards and associated clear ecolabelling. Likewise, the variety of factors affecting their degradation in the open environment makes them potentially hazardous or harmful if not used and collected for composting at centralized sites.[xiii]

This confirms that only compostable plastics, that meet relevant, robust standards on compostability, may be considered, and only in connection with separate collection of organics and composting schemes.

Recycling is not enough

There is no closed-loop mechanical recycling for plastics. While most plastics are low-grade and difficult or impossible to recycle, even high-grade plastics can only be recycled a few times before being downcycled, incinerated, landfilled or ending up in nature. Recycling delays, rather than prevents, the final disposal of plastic waste.

Recycling does have a role in managing existing plastic, as long as measures are taken to limit the re-circulation of toxic additives, and in conjunction with upstream measures to drastically reduce plastic waste in the first place. Recycling cannot absorb all current plastic waste, let alone tackle booming new plastic production. We cannot recycle our way out of plastic pollution.

No closed-loop recycling for plastics

Plastics cannot be recycled mechanically in a closed loop, because they lose quality with recycling. In contrast, steel, aluminium and glass can be endlessly recycled in a closed loop, and have notably been displaced by plastics in many products and packaging. The facts speak for themselves: only 9% of plastics discarded since 1950 have been recycled - the rest has been dumped in landfills, burned, or has ended up in the environment, where it will remain for millennia.[xiv]

Plastic recycling pollutes

Recycling and downcycling plastics sometimes exacerbate plastic pollution. The processes of mechanical plastic recycling and downcycling plastic into road and construction materials ("plastic to brick", "plasphalt") both pollute when heated plastics release toxic emissions and put the health of workers and communities at risk.[xv] The heating required also makes these processes energy-intensive.

The products of plastic recycling also pollute the environment and disrupt human health. This pollution occurs through fragmentation, including when solid plastic waste is downcycled into plastic textile for clothing, leaching microplastic and nanoplastic fibers that accumulate in the environment.

Recycled products also pollute by leaching toxic additives contained in the original plastics. Recycled plastic toys, kitchen utensils and hair accessories have been found to contain dangerously high levels of brominated flame-retardants from e-waste, which are not chemically bound to plastic materials and leach into the environment. Brominated flame-retardants are listed under the Stockholm Convention as "persistent organic pollutants". They disrupt thyroid function and brain development, and cause long-term neurological damage. Robust regulation is needed to ensure recycled products are toxic-free and to eliminate hazardous waste such as e-waste from the recycling loop.[xvi]

Recycled plastic roads and construction materials exposed to the elements also threaten to leach toxic substances, as well as microplastics and nanoplastics, into nature. Roads and construction materials are exposed to environmental stresses such as heat, ultraviolet radiation, wind, rain, and passing vehicles, which all increase the risk of fragmentation of plastic materials and leaching of toxic substances. Rain turns roads into waterways, leading these toxins to accumulate in rivers and oceans.[xvii] In addition, plastics exposed to solar radiation are likely to release greenhouse gases, as is already proven for PET.[xviii]

Recycling cannot stem the tide of new plastic waste

Plastic recycling is open-loop and as such, it cannot stop new plastic production: it feeds on single-use plastics and perpetuates a throw-away, wasteful linear economy. At the same time, recycled plastics cannot compete with cheap new plastics flooding the market, or with the volume of plastic consumption associated with single-use plastic products and packaging.

Recycling should only be seen as a complement to large scale transformation of plastic production, product and packaging redesign, and consumption. Recycling only makes sense at the end of the waste hierarchy, after waste has been drastically reduced with upstream measures, and reused. It is only sustainable insofar as its environmental impact remains low.

Recyclable bio-based plastics have their own challenges

Some bio-based plastics (at least partly-derived from biomass feedstocks) are recyclable. They require their own streams in order not to compromise the quality of recycled fossil-fuel-based plastics. Increasing the number of streams for plastic recycling increases the complexity and cost of recycling.

In addition, while bio-based recyclable plastics have less fossil fuel feedstocks than conventional recyclable plastics (or none), that doesn't make them necessarily sustainable. Fossil fuel feedstocks have deeply problematic and well-known climate and other environmental impacts, while biomass feedstocks from industrial agriculture may be highly problematic, too, due to deforestation, soil degradation, water scarcity and pollution, biodiversity loss, and climate change impacts.

Biomass feedstocks are also associated with negative social impacts, as industrial agriculture puts pressure on land and food prices, undermining land and food security, particularly for vulnerable communities in the Global South. Land speculation concentrates ownership in the hands of transnational corporations, and local smallholders do not benefit from the economic growth from large-scale biomass production. Increased rural poverty threatens to deepen the gender gap. Deforestation also harms indigenous and local communities whose lives and livelihoods depend on forested areas.[xix]

Biomass feedstocks from agricultural or inedible food waste are preferable due to their lighter environmental and social impacts. However, sustainable biomass feedstocks are not currently available to the scale required in order to substitute all fossil-based plastics with bio-based plastics.

Much plastic recycling is North-South waste-dumping in disguise

The unsustainability of plastic recycling has triggered a crisis in the sector as China and other Asian countries have refused to become the world's dumping ground for post-consumer plastic waste.

The global plastic waste trade leads plastic to be exported for recycling in places without adequate pollution controls. Countries of the Global North (particularly the US, Europe and Japan) export large portions of their plastic waste to the Global South. Much of this plastic waste cannot be safely, economically or effectively recycled, and ends up in incinerators, landfills, or the open environment. Global North countries claim that such plastic waste is "recycled" and claim to be sustainable, although they rarely track the waste to verify what ultimately happens. The health and environmental cost of this global waste transfer are so high that China and other receiving countries in South-East Asia have started to ban plastic waste imports, leading to a crisis in plastics recycling.[xx]

Chemical recycling without sound chemicals management

The chemical recycling of plastics transforms synthetic polymers into their basic units or larger chain fragments in order to produce new plastic materials. It uses a combination of chemicals, heat, pressure, electricity, and even microwave irradiation. Closed-loop chemical recycling reproduces the same material, whereas open-loop recycling produces different materials (sometimes of higher, but typically of lower, value). Alternative terms include chemical “depolymerization" or "feedstocks recovery."

Plastic chemical recycling was developed in the 1950s, and so far has been a polluting, energy and resource-intensive process. Current initiatives appear to fall short in terms of sound chemicals management, energy efficiency, affordability, and scalability.

Chemical recycling is toxic, resource and energy-intensive

Chemical recycling can involve toxic chemicals as solvents and catalysts, as well as in the preparation and refining of products. These substances include petrochemicals (such as ethylene glycol) and heavy metals (zinc, lead), which require sound chemicals management. New chemical recycling processes under development also involve nanoparticles, which must also be managed with great care, given nanoparticles can pass through cell walls and affect cell function.

Chemical recycling so far has struggled to achieve high efficiency, meaning the quantities of chemicals required for chemical recycling make it a resource-intensive process that could deplete precious mineral resources. Chemical recycling also often requires significant energy inputs to create heat, pressure, electricity or microwave irradiation. This could have significant climate change and pollution impacts.

Chemical recycling is expensive and could exacerbate the demand for plastic waste

Given its resource, energy and infrastructure-intensive nature, chemical recycling is currently too costly to be a large-scale solution to plastic waste and is highly in-adapted to a developing and small island states where most of the plastic is currently found. Chemical recycling infrastructure is also expensive, and could create a lock-in effect. This means that chemical recycling, and open-loop chemical recycling in particular, threatens to create demand for increasing volumes of new plastic waste. This would also exacerbate the pollution and climate change impacts associated with plastic production.

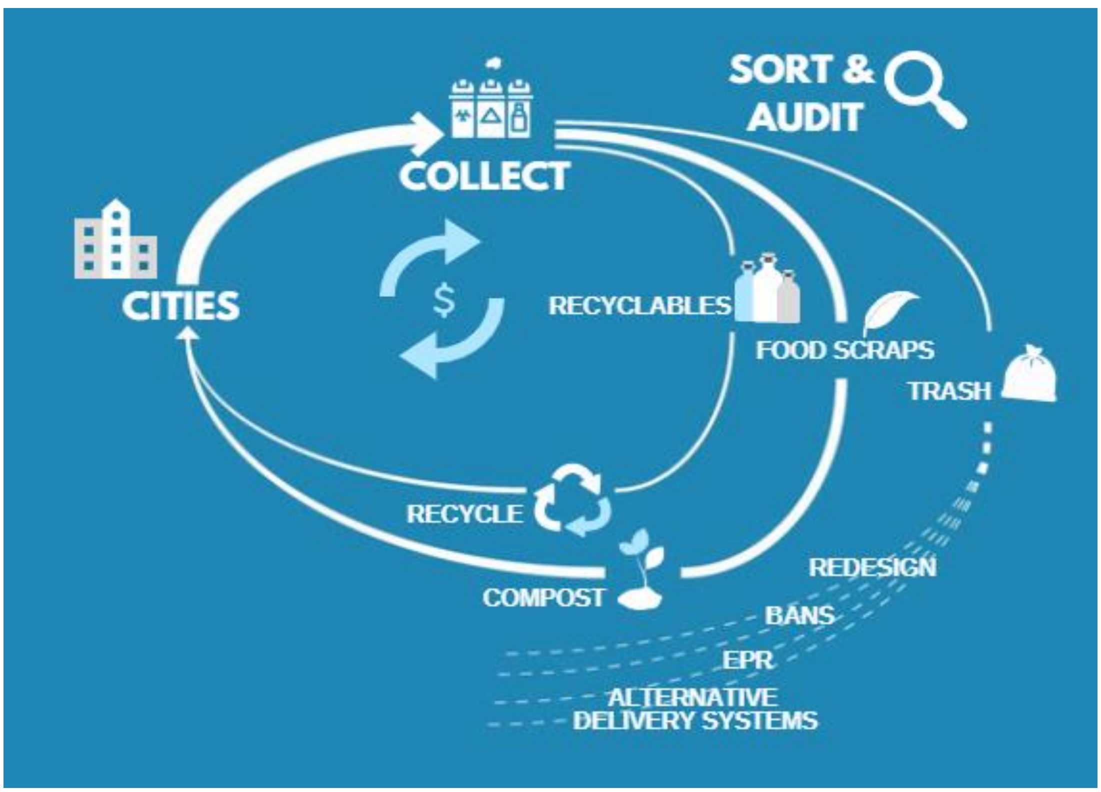
Feedstock recycling usually involves incineration and pollutes

Chemical recycling also refers to transforming plastics in chemicals or other materials to be later used for different purposes than the original material, frequently as fuel. This process is also called “feedstock recycling”. It includes "plastic-to-energy" or "plastic-to-fuel" processes including gasification, pyrolysis, and plasma arc. These processes do not qualify as recycling under global standards, nor do they qualify as renewable energy. Gasification, pyrolysis and plasma-arc plants for plastic waste are considered to be types of incinerators that pose similar pollution and greenhouse gas emission concerns as conventional waste incinerators. They are also expensive, energy-intensive processes and in-adapted to developing country and Island state setting.

The real solution to plastic waste: reduction and a zero-waste circular economy

Solving the plastic pollution crisis will require comprehensive global policy solutions to reduce plastic production. In parallel, city, national and regional bans on unnecessary single-use, disposable plastics are a good starting point, and are vital to stem the tsunami of new plastic production and waste that is threatening to wash away plastic waste management efforts.[xxi]

Zero waste tackles plastic pollution through a systemic approach to waste prevention and reduction. The zero waste cycle starts with a separate collection and waste-audit system which enables the capture and reuse of waste with an iterative evaluation process. Following waste audits and assessments, cities and national governments can implement adequate policy tools such as bans on unnecessary single-use items that are not practically recyclable or compostable in local systems. Zero waste also supplies steady jobs to waste workers who provide separate collection, recycling and composting across cities. Zero waste does not include incineration, and cities aim for zero residual waste overall.



ZERO WASTE POLICY TOOLS AT EACH STAGE OF PLASTIC PRODUCTION AND CONSUMPTION

Enforced legislative efforts and adequate budget allocation are key to a successful implementation of zero waste systems. Actions that are applicable to many communities include:

PRODUCTION

Extended Producer Responsibility (EPR) – In accordance with the "polluter pays" principle, producers should be held accountable for the end of life of their products with financial and/or physical responsibilities.

DISTRIBUTION

Bans on products that cannot be recycled easily such as polystyrene food containers and plastic bags are an effective way to reduce waste, as many African cities have already witnessed. Bottle bills that require deposits to be paid on beverages sold in bottles can ensure a high rate of recycling.

RECYCLING

Investment in source separation and collection can make waste recycling easier and better capture the value of recovered materials. Minimum recycled contents requirements as well as better labeling of recyclability function as an incentive.

DISPOSAL

Pay-As-You-Throw (unit pricing waste collection system) creates a direct economic incentive to recycle more and to generate less waste. Through disposal bans on recyclables, organics, electronics, and hazardous waste, cities can divert certain materials from landfills and incineration.

OTHER FINANCIAL MEASURES

Increased tipping fees, tax benefits for recycling and composting, and higher taxation on non-recyclables are part of revenue models that are applied for zero waste cities.

Endnotes

[i] Vandenberg, L. N., et al., "Regulatory decisions on endocrine disrupting chemicals should be based on the principles of endocrinology", Reproductive Toxicology, 2013 38, 1-15. Thompson, R. C., et al., "Plastics, the environment and human health: current consensus and future trends", Philosophical Transactions of the Royal Society of London, Series B: Biological Sciences, 2009. Farrelly, T.A. and Shaw, I, "Polystyrene as Hazardous Household Waste", Intech, 2017.
[ii] Geueke B., et al., "Prioritization approaches for hazardous chemicals associated with plastic packaging", Food Packaging Forum, 2018.
[iii] Zeng E. Y. (ed), *Microplastic Contamination in Aquatic Environments: An Emerging Matter of Environmental Urgency*, Elsevier 2018; Chen, Q. et al., "Enhanced uptake of BPA in the presence of nanoplastics can lead to neurotoxic effects in adult zebrafish", Science of the Total Environment, 2017; Chae Y. et al, "Trophic transfer and individual impact of nano-sized polystyrene in a four-species freshwater food chain", Scientific Reports, 2018.
[iv] GAIA is grateful to Dr Trisia Farrelly of Massey University for her expert guidance and contributions to this briefing.
[v] See also Greenpeace, "A Crisis of Convenience: The corporations behind the plastics pollution pandemic", 2018.
[vi] GAIA, "Incinerators in Trouble", 2018.
[vii] Rollinson A. N., Oladejo J. M., "'Patented blunderings', efficiency awareness, and self-sustainability claims in the pyrolysis energy from waste sector", 2018; GAIA, "Facts about 'Waste-to-Energy' Incinerators", 2018; GAIA, "Waste Gasification & Pyrolysis: High Risk, Low Yield Processes for Waste Management", 2017.
[viii] Vahk J. & Zero Waste Europe, "The Nordics' addiction to incineration fuels the controversy on renewable energy", 2018.
[ix] Roberta Arbinolo, "European Parliament takes historic stand against single-use plastic pollution", Zero Waste Europe, 2018.
[x] C. Schulze et al, "Energy Analysis of Bioplastics Processing", *Procedia CIRP,* 2017.
[xi] Surfrider Foundation Europe, Friends of the Earth Europe, Zero Waste Europe, Ecos, European Environmental Bureau, "Bioplastics in a Circular Economy: The need to focus on waste reduction and prevention to avoid false solutions", 2017.
[xii] World Cleanup Day, "What are biodegradable plastics?", 2018.
[xiii] Allen K. et al, B.A.N. List 2.0: An analysis and call-to-action to phase out the most polluting plastic products used in the United States, 2018; Casey, Z., "So-called "bioplastics" won't solve the plastic pollution problem", Zero Waste Europe, 2018; UNEP, Biodegradable Plastics and Marine Litter. Misconceptions, concerns and impacts on marine environments, 2015.
[xiv] Jambeck J., et al, "Production, use and fate of all plastic ever made", Science Advances, 2017.
[xv] Tsai C.J., Chen M.L., Chang K.F., Chang F.K., Mao I.F, "The pollution characteristics of odor, volatile organochlorinated compounds and polycyclic aromatic hydrocarbons emitted from plastic waste recycling plants", *Chemosphere*, 2008; Lindberg H.K. et al, "Genotoxic effects of fumes from asphalt modified with waste plastic and tall oil pitch", Mutation Research, 2018.
[xvi] DiGangi J., et al., "POPs Recycling Contaminates Children's Toys with Toxic Flame Retardants", Arnika, IPEN, 2017; Straková J., et al., "Toxic Loophole: Recycling Hazardous Waste into New Products", Arnika, IPEN, HEAL, 2018.
[xvii] Boucher J. and Friot D., "Primary Microplastics in the Oceans: A Global Evaluation of Sources", IUCN, 2017.
[xviii] Royer S. J., et al., "Production of methane and ethylene from plastic in the environment" PLOS ONE, 2018.
[xix] Friends of the Earth Europe, "Land under pressure: Global impacts of the EU bioeconomy", 2016.
[xx] GAIA and Zero Waste Europe, "Recycling is not enough", 2018; Hook L. and Reed J., "Why the world's recycling system stopped working", Financial Times, 2018; Basel Action Network, "Export of e-Waste from Canada: A Story as Told by GPS trackers", 2018; GAIA, "Plastic waste trade: After China's ban, more countries restrict imports", 2018.
[xxi] A wave of new plastic infrastructure investments, combined with the availability of cheap fossil fuel feedstocks, are expected to increase new production of fossil-based plastic almost four-fold by 2050: CIEL "Fueling Plastics: How Fracked Gas, Cheap Oil, and Unburnable Coal are Driving the Plastics Boom", 2017 By that point, the plastics sector is projected to account for 20% of total oil consumption, against 8% today: World Economic Forum, Ellen MacArthur Foundation & McKinsey & Company, "The New Plastics Economy: Rethinking the future of plastics", 2016. Meanwhile, the broader petrochemical industry currently consumes 14% of global oil production and is expected to consume nearly half of global oil production by 2050: International Energy Agency, "The Future of Petrochemicals", 2018.