PLASTIC SOLUTIONS REVIEW

ASSESSMENT OF SOLUTIONS TO PLASTIC WASTE AND RECOMMENDATIONS TO POLICY MAKERS

Photo credit: Break Free From Plastic

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INTRODUCTION

The world is currently being flooded with millions of tons of new plastic every year. The availability of cheap natural gas has accelerated production to over 330 million tons annually, a figure that is expected to double over the next 20 years.[1] Most commonly, this mass of plastic is used for a single, short-lived purpose, before ending up in landfills or open dumps, being littered on land or in the ocean, burned and turned into air pollution, or degraded into tiny microplastics that turn up in the tissue of living organisms ranging from fish to humans.[2]

The most well-known impact of this plastic waste is perhaps its effect on animals in the open environment, and particularly marine environments, where large plastic waste like soda rings and plastic bags tangle and suffocate animals, and smaller pieces kill animals that eat too much of it.[3]

But the impacts of plastic waste don't stop there.

Exposure to plastic materials and additives like phthalates and bisphenol-A (BPA) has been linked to developmental problems, reproductive disorders, endocrine system disruption, and cancers in animals and humans.[4] Microplastics – microscopic plastic particles that are formed as plastic products degrade – are of particular concern. Their small size makes them able to spread everywhere, and microplastics have been found in the digestive tracts of fish, in tap water in the US, and even in human placentas.

Beyond affecting animal and human health, this buildup of plastic waste worldwide damages livelihoods that depend on tourism, fishing, and agriculture,[5] with estimated annual negative economic impacts of over 40 billion USD from plastic packaging alone.[6] Plastic's indirect impacts, including those on climate and human health, are just as pressing. Plastic production is highly carbon-intensive, requiring energy inputs at every stage of its life, from the drilling of fossil fuel inputs to the common end treatment of incineration, and plastic is projected to account for as much as 20% of oil use by 2050. It is also highly polluting, contributing to asthma, heart disease, and cancer rates in the communities living near drilling sites, manufacturing plants, and waste incinerators.[7]

Plastic is threatening ecosystems, livelihoods, human health, and climate stability worldwide, and something must be done to stem the tide of plastic production. But while the plastic flow must be reduced at the source, what solutions do we have to manage the plastic waste that is submerging us every day? How can we clarify which solutions are truly effective, and which should be avoided and classified as false solutions, although they may look good on paper?

#Break Free From Plastic, a global movement fighting against waste pollution (of which Ecosoum is Core Member), created a website entitled 'Plastic Solutions Review', where a panel of scientific

[1] Ellen MacArthur Foundation (2017).

[2] Ellen MacArthur Foundation (2017).

[3] Oceana (2020).

[4] CIEL (2019).

[5] UNEP (2021).

[6] Ellen MacArthur Foundation (2017).

[7] UNEP (2021).

experts[8] assess various available solutions to manage plastic waste. Based on the most advanced scientific knowledge, these sourced assessments offer clear explanations to understand the advantages and problems of each technique, which should guide decision-makers when designing their waste management public policies.

This report presents the main information currently available in the 'Plastic Solutions Review'. Based on the conclusions of this review and the lessons learnt from its experience managing waste in Khishig-Undur soum (Bulgan aimag, Mongolia), Ecosoum then suggests recommendations to solve the waste crisis in our country.

REVIEW OF AVAILABLE PLASTIC SOLUTIONS

RECYCLING

The advantages and drawbacks of recycling (intended as the process of melting and reshaping plastic waste) have been thoroughly explained in Ecosoum's "Zero-Waste and Circular Economy: The Way Forward" report.[9] Thus, will not be discussed further here. However, the main conclusions should me reminded: recycling certainly has a role to play in waste management, but it should absolutely not be seen as a perfect, ultimate solution to plastic waste.

Plastic recycling actually raises a lot of practical, logistical, financial, social and ecological issues that can't be disregarded when building relevant waste management public policies. In fact, national policies relying primarily on recycling are doomed to fail due to the many intrinsic limits and counter-productive effects of recycling.

In a nutshell, recycling is probably indispensable, but most definitely insufficient, which is why it should not be carelessly over-promoted. On the contrary, to be relevant and sustainable, it should be considered wisely, with knowledge and caution.

INCINERATION AND WASTE-TO-ENERGY

Incineration is the process of burning waste. Most incineration facilities use the resulting heat to generate a small amount of electricity, and industry usually refers to the process as 'waste-to-energy' (or 'energy recovery'). Most commonly, incinerators burn mixed municipal solid waste that includes plastic waste, but sometimes waste is pre-treated or sorted to reduce moisture content or the amount of hard-to-burn materials like electrical appliances.

In addition to generating energy, the incineration process also produces carbon dioxide emissions, air pollutants, fly-ash, and other solid waste residue. Incineration should not be confused with other thermal treatments like those involved in chemical recycling or plastic-to-fuel processes, which use heat to convert plastic waste into liquids or gases that can either be made into new plastic or burned as fuel.

[8] The Expert Review Panel's composition is presented on the website: https://plasticsolutionsreview.com/plastic-solutions-review-panel/

[9] Ecosoum (2021).

Since incineration has been broadly used worldwide, it is often one of the first solutions that come to mind when looking for waste management processes. However, is incineration a truly legitimate technic to contribute in solving the waste crisis, or not?

Waste incineration actually falls short of being an effective solution to the plastics crisis on a number of fronts. First, waste incineration incentivizes and relies upon the continued production of waste, including plastic waste. Incinerators, which usually burn mixed municipal solid waste, depend on energy-dense materials like plastic to maintain high burn temperatures and generate heat. Without enough plastic in the waste stream, incinerators require other fossil fuel inputs to effectively incinerate organic matter and hard-to-burn materials in the waste stream.

In China, for example, incinerator operators routinely add coal to the municipal waste to make it combustible.[10] Therefore, incinerator companies have an incentive to keep plastic in the municipal waste stream, rather than implement strategies to reduce, reuse, or recycle plastic waste. For this reason, incineration often competes with local recycling systems for plastic, and can take livelihoods away from waste workers, waste pickers, recyclers, and plastic haulers.[11]

Beyond the conflict it creates with other plastic waste solutions, incineration generates new issues by converting plastic waste into carbon dioxide and pollutants. Conventional plastics burned in incinerators are fossil fuels, and for every ton of plastic burned, as much as three tons of CO_2 are released into the atmosphere.[12]

Incineration produces more greenhouse gas emissions per unit of energy produced than any other form of energy production.[13] Along with greenhouse gases, incineration also generates toxic emissions that include dioxins, particulate matter, carbon monoxide, nitrogen oxides and other acidic gases (SOx, HCl), metals (cadmium, lead, mercury, arsenic, and chromium), polychlorinated biphenyls (PCBs), and brominated polyaromatic hydrocarbons (PAHS).[14] These byproducts not only risk the well-being of workers and nearby residents that are directly exposed to emissions, but also pose a larger risk when they are deposited in the open environment where they can accumulate in waterways and the food chain.[15] Moreover, in the case of dioxins, the periodic emission testing methods used in most countries do not capture episodes of high dioxin releases, which can only be found through continuous monitoring, a practice which many developing countries have no capacity to conduct.[16]

While modern air pollution control equipment can help reduce the amount of toxins in an incinerator's exhaust gas, it does so by concentrating some of the toxins in other byproducts like ash and wastewater.[17] The resulting toxic ash, which can represent over a third of the original burned material, is often disposed of in landfills where it can easily be spread by wind into the surrounding environment.[18] In other cases, incinerator ash is used as a supplement in concrete or

[10] M. Adams (2012) ; Roberts-Davis, T.L., Guerrero, L.B. (2018).

[11] Luthra, A. (2017) ; Gerdes, P., & Gunsilius, E. (2010) ; Global Alliance for Incinerator Alternatives (2013).

[12] Material Economics (2018).

[13] Tangri, N. V. (2021).

[14] The New School Tishman Environment and Design Center (2019) ; Azoulay, D. and al. (2019).

[15] Tait, P. W. and al. (2020) ; Allsopp, M. and al. (2001) ; Petrlik, J., & Bell, L. (2020).

[16] Jurgen, R., Weber, R., & Watson, A. (2008).

[17] Petrlik, J., & Bell, L. (2020).

[18] Petrlik, J., & Bell, L. (2020).

asphalt, and is even used as fertilizer for agriculture, further increasing the risk that incineration byproducts end up in the environment and in people's bodies.[19]

Exposure to these byproducts has significant health implications. Studies of fence line communities near waste incinerators have revealed terrible outcomes for those exposed to incinerator pollutants, including increased rates of preterm births, increased wheezing, headaches, stomach aches, and fatigue in schoolchildren, increased risk of miscarriages from exposure to particulate matter, increased risk of lymphoma due to dioxin emissions, and excess deaths due to stomach, liver, colon, and other cancers.[20] Moreover, these impacts are often shouldered by marginalized communities that are disproportionately exposed to industrial pollution. In the US, as many as 8 out of 10 incinerators are sited in low-income communities or communities of color, often alongside other polluting industrial facilities.[21]

Beyond being an environmental and health liability, incineration often fails to deliver its basic services of waste disposal and energy generation in a cost-effective manner. Incineration is the most expensive waste management strategy, with high upfront capital costs and continued high operational costs to cover pollution control, air quality monitoring, wastewater management, and ash disposal.[22] Waste-to-energy can cost as much as USD $190-1200 per ton of waste handled per year, compared to landfill's range of USD $5-50 per ton per year.[23]

Incineration is one of the most expensive ways to generate electricity, costing four times as much per unit of energy as solar or onshore wind, twice as much as natural gas, and 25% more than coal.[24] It's also highly inefficient. After taking the embedded energy in incinerated waste into account, analysis shows that 'waste-to-energy' actually wastes more energy than it produces.[25] High costs and inefficiencies often lead to incinerator facility closures, and can end up costing municipalities that use 'waste-to-energy' considerable amounts to decommission and find waste management alternatives. Since 2000, 31 municipal solid waste incinerators in the US have closed, largely due to insufficient revenue to cover costs, and in some cases, cities have even been driven to bankruptcy by failed 'waste-to-energy' projects.[26] In turn, these costs are assumed by the public through taxes and high garbage bills, further burdening the low-income communities that are often exposed to facility emissions as previously discussed.

All in all, incineration's environmental and health impacts create new problems for plastic waste management while failing to compete economically with other, less carbon-intensive waste management strategies or energy generation technologies. These factors, coupled with the technology's reliance on plastic waste make it a poor tool for tackling the plastics crisis.

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[19] Petrlik, J., & Bell, L. (2020).

[20] The New School Tishman Environment and Design Center (2019) ; Azoulay, D. and al. (2019) ; Tait, P. W. and al. (2020) ; National Research Council (2000) ; Garcia-Perez, J., and al. (2013) ; Ranzi, A., and al. (2011).

[21] The New School Tishman Environment and Design Center (2019) ; Schwarz, L., and al. (2015) ; Martuzzi, M., and al. (2010) ; Baptista, A. I., & Amarnath, K. K. (2016).

[22] Moon, D. (2021).

[23] Moon, D. (2021).

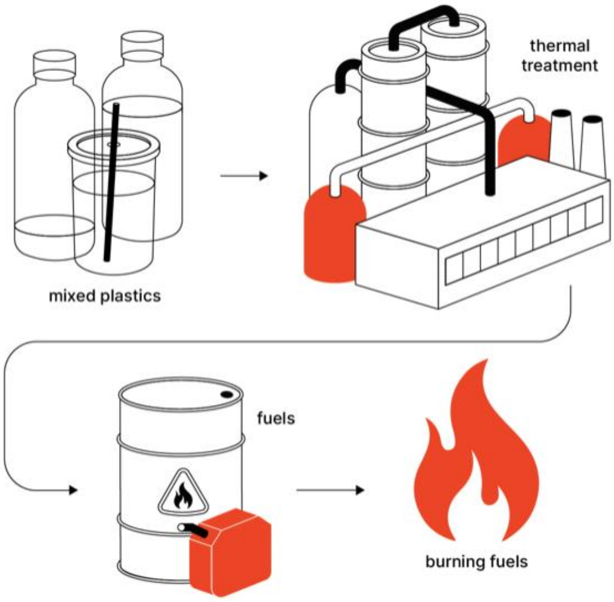
[24] Morris, J. (2005).

[25] Moon, D. (2021).

[26] The New School Tishman Environment and Design Center (2019) ; Tavernise, S. (2011).

PLASTIC-TO-FUEL

Plastic-to-fuel (or PTF) processes use heat, pressure, and/or chemical solvents to break plastic waste down into liquids or gases that can be burned as fuel. The term is often misleadingly categorized as “chemical recycling” (which is described and assessed in the next section), which is a process that uses similar methods to break plastic waste down into constituent parts that can be made into new plastic. But while some of the same technical processes are used in both treatments to break down plastic waste, if the end product is ultimately burned, the treatment is called plastic-to-fuel.



Source: [*GAIA Q&A*]

By turning plastic waste into fuels to be burned, plastic-to-fuel fundamentally does nothing to reduce plastic waste production or decrease the need for new plastic. At the same time, it produces significant greenhouse gas emissions by turning fossil fuel-based plastics into CO_2 and air pollutants. Overall, PTF suffers from technical, economic, and environmental challenges that threaten its own viability as well as the climate and human health.

Despite decades of development, plastic-to-fuel’s biggest challenge is its basic technological viability. As a highly complex process, PTF faces many technical challenges including:

- Limitations on the types of plastics that can be processed;
- The sorting and cleaning of contaminated plastic waste feedstock;
- Temperature control during conversion processes;
- Removal of impurities from end products;
- Management of toxins present in resulting waste residues.

These issues have led PTF facilities to fall short on projected energy and revenue generation, miss emission targets, sustain corrosive damage to building structures, and even suffer fires and explosions.[27] An expert review of the available evidence on the technology in 2020 concluded that

[27] Zero Waste Europe (2015) ; Rollinson, A. N., Oladejo, J. M. (2019) ; Gleis, M. (2012) ; Rollinson, A. N. (2018) ; Tangri, N., Wilson, M. (2017).

PTF is technologically immature, unsustainable, and presents a risk to potential investors,[28] a statement that is reflected by the fact that over $2 billion has been spent on failed or cancelled gasification or pyrolysis facilities in the US as of 2017.[29]

All of the above technical challenges drive up cost and risk for PTF facilities, adding an economic barrier to its further development. To make up for this, PTF companies sometimes seek government subsidies, and to date the US has spent over $450 million in taxpayer dollars to fund such projects.[30] In this way, PTF poses the additional risk of sapping much-needed resources that could be spent on the development of other, more viable solutions to the plastics crisis.

Moreover, by converting plastic waste into fuel for combustion, PTF effectively turns plastic waste into carbon dioxide and air pollutants, increasing the overall environmental impact associated with plastic production. Robust life cycle assessments and data from a US PTF company indicate that the carbon dioxide emissions associated with the fuel resulting from PTF processes are at least as carbon-intensive as conventional fossil fuels.[31]

Toxic emissions from PTF end-products are also worse than those resulting from burning conventional fuels: diesels and waxes produced from PTF processes contain more toxic residues, dioxins, persistent organic pollutants (POPs), and PAHs (a class of compounds that could cause liver and kidney damage or cancer), than conventional diesel, and their burning produces more air pollutants like NOx, soot, and carbon monoxide than regular diesel.[32]

The cleaning process to remove these toxins from PTF end-products is difficult and expensive, and creates more environmental impacts, barriers to implementation, and additional toxic waste streams.[33] Moreover, the treatment plants that handle and generate said toxic materials are often sited in vulnerable communities, i.e. indigenous, low-income communities, and/or communities of color that are disproportionately exposed to industrial emissions.[34] The toxic legacy of PTF processes is compounded in lower-income countries that often lack laboratory infrastructure to monitor chemical emissions and the regulatory frameworks to monitor and enforce emission standards.

Finally, PTF projects are expensive and require substantial financial investment. This can create a ‘lock-in’ effect, whereby the reliable delivery of feedstock (plastic waste) is essential to secure the pay-back on that investment. Often, this is secured through “deliver or pay” contracts that demand continued delivery of plastic waste, hampering efforts to improve plastic reduction, reuse, and recycling.

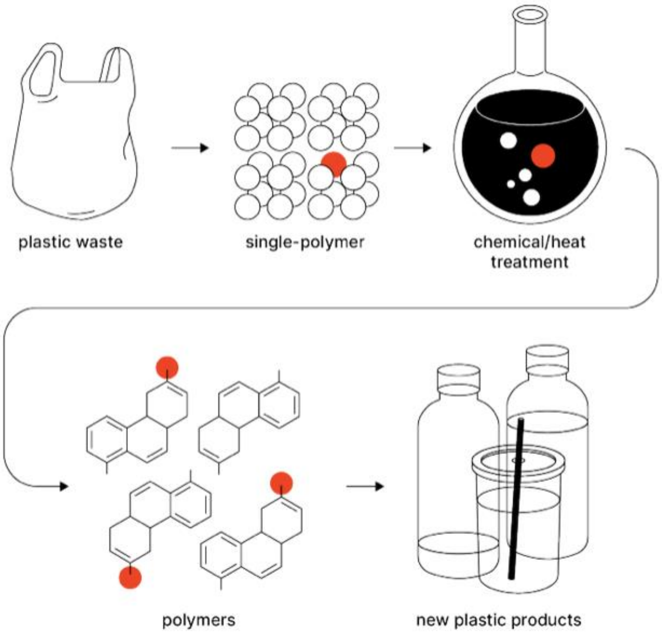
Plastic-to-fuel is a demonstrably risky technology that exacerbates environmental and social problems rather than solves them. It has no role to play in solving the plastics crisis.

[28] Rollinson, A., Oladejo, J. (2020).
[29] Tangri, N., Wilson, M. (2017).
[30] Schlegel, I. (2020).
[31] Šerdoner, A. (2020).
[32] Rollinson, A., Oladejo, J. (2020).
[33] Rollinson, A., Oladejo, J. (2020).
[34] Petrlik, J., & Bell, L. (2020).

CHEMICAL RECYCLING

Chemical recycling[35] is a group of processes that uses heat, pressure, and/or chemical solvents to break plastic waste into its basic building blocks, which can then be remade into new plastic.

Due to misuse of the term, chemical recycling is often confused with "plastic-to-fuel" processes that break plastic waste down into liquids or gases before burning them as fuel (as explained above). While some of the technical processes involved are the same for chemical recycling as for plastic-to-fuel, processing plastic waste so that it can be burned is not recycling, and any thermal or chemical treatment should only be called chemical recycling if the end result is new plastic.



Source: GAIA Q&A

In theory, chemical recycling offers an interesting approach to managing plastic waste, particularly for plastics that are otherwise difficult to recycle. In practice, however, it is technologically immature, economically infeasible, logistically challenging, has a significant carbon footprint, and results in toxic byproducts that threaten human and ecological health.

Chemical recycling struggles to deliver its basic promise of turning plastic waste into new plastic. While it is theoretically possible to have minimal or even nonexistent losses of plastic material in chemical recycling, in practice, each loop through the process results in significant losses of raw material, perpetuating the need for new plastic inputs.[36] Often, material is lost in pre-sorting, burned up in the treatment process itself (producing harmful emissions), or too contaminated or low quality to be used for new plastic. Most plastic products include a wide range of additives, further complicating chemical recycling.

Data from a chemical recycling facility shows that as much as 35% of plastic input material can be lost in the recycling process.[37] Chemical recycling's proposed "circularity" is further hampered by the infrastructure and incredible amounts of energy required for operation. Energy is needed to

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[35] Also known as *advanced recycling* or *tertiary recycling*. Thiounn, T., & Smith, R. C. (2020).

[36] Eunomia, *Chemical Recycling*... (2020).

[37] Patel, D., and al. (2020).

sort feedstock materials, run machinery, provide large amounts of heat for thermal treatment, and clean the toxic byproducts created in the process. These energy inputs in turn contribute to carbon emissions and raise production costs, so much so that chemically recycled plastic struggles to compete with low-cost virgin plastic.[38] The material losses and energy inputs described above make chemical recycling an energy-intensive project with a large carbon footprint.

Based on data from a chemical recycling facility, 3.9 kilograms of CO_2 can be emitted for every 1 kilogram of new plastic produced, not including the lifecycle carbon emissions associated with the production of the original plastic waste used as an input, or the emissions associated with post-processing.[39]

These limitations are reflected most plainly by the fact that chemical recycling is almost non-existent in the real world. Data from the US shows that out of 37 proposed chemical recycling projects since 2000, only 3 were operational as of 2020, and none successfully produced new plastic at a commercial scale.[40] Notably, in the case of thermal cracking systems, the most widespread technology for chemical recycling, plants that are labeled as chemical or advanced recycling facilities in reality burn most or all of what they ultimately produce, making them in effect plastic-to-fuel plants.[41]

While there is very little transparency on the part of chemical recycling plants about their emissions and byproducts, these facilities likely operate similarly to others in the petrochemical industry, which produce large amounts of toxic air pollutants, liquid effluent, and solid waste. In one pilot chemical recycling plant for multilayer plastic packaging, as much as 25-40% of the input material was converted to waste.[42] Moreover, chemically and thermally treating plastic waste is known to release many toxins, including some that are already banned by national regulations, such as bisphenol-A (BPA), cadmium, and benzene, among many others.[43] The toxicity, fate, and characteristics of the residues created by decontaminating plastic waste have not been made public, nor have the hazards associated with the proprietary catalysts used in depolymerization.[44] This varied and poorly studied waste stream represents a significant hazard for chemical recycling, particularly for developing countries that do not have the appropriate facilities to manage new forms of mixed toxic waste.

Finally, the facilities themselves, as well as the facilities that process their end products and/or toxic waste, are often sited in low-income communities and communities of color already facing significant health burdens from existing industrial emissions.[45] Investing in more chemical recycling plants means increasing the pollution burden on these communities while providing little to no tangible benefits to the world at large.

All in all, the material losses, energy inputs, and environmental hazards associated with chemical recycling make it an expensive and poor strategy for solving the plastics crisis.

[38] Patel, D., and al. (2020) ; Brock, J., and al. (2021).
[39] Patel, D., and al. (2020).
[40] Patel, D., and al. (2020).
[41] Patel, D., and al. (2020) ; Zero Waste Europe et al. (2020).
[42] Patel, D., and al. (2020).
[43] Rollinson, A., Oladejo, J. (2020).
[44] Bell, L., & Takada, H. (2021).
[45] Patel, D., and al. (2020).

BIOPLASTICS

WHAT EXACTLY ARE "BIOPLASTICS"?

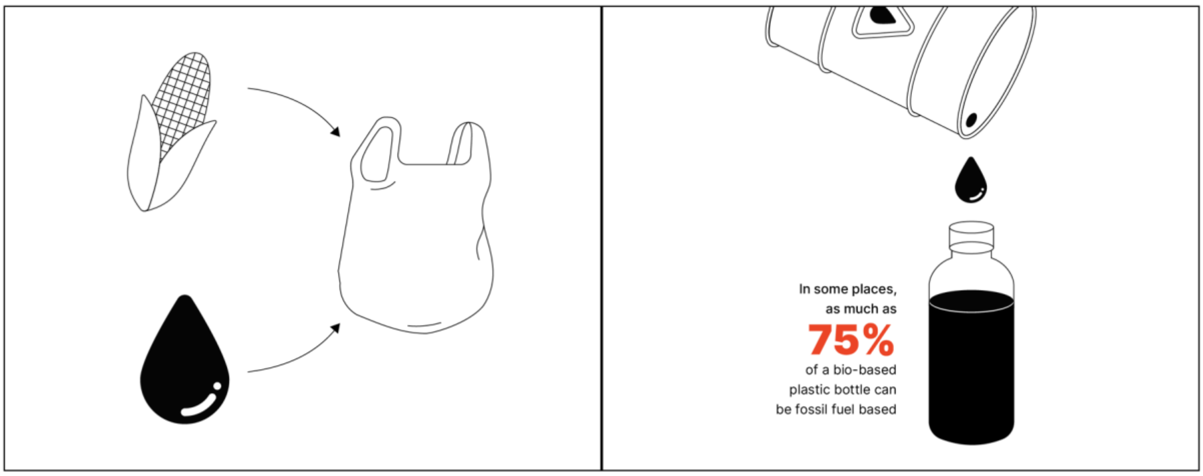
The definition of the term "bioplastics" varies greatly around the world. It is most commonly used to refer to bio-based, biodegradable, and/or compostable plastics, but things are never clear. For example, some people define bioplastics as plastics that are "bio-based, biodegradable, or both," while others define bioplastics as "biodegradable materials that come from renewable sources."

Conflicting definitions like these make "bioplastic" an unhelpful term that confuses policy-makers and consumers about the difference between bio-based, biodegradable, and compostable materials. But this difference is actually huge because one of the terms (bio-based) refer to the source of the material use to make the 'bioplastic', while the other two terms (biodegradable and compostable) refer to its end-of-life behavior. For this reason, we should avoid using the term bioplastics, and instead analyze bio-based and biodegradable / compostable plastics separately.

BIO-BASED PLASTICS

Bio-based plastics are plastics that are partly or entirely made from biological feedstocks, such as sugar cane, corn, or potato starch. These 'bio-plastics' are often chemically and functionally identical to conventional, fossil fuel-based plastics. Some bio-based plastics are also biodegradable, but many are not. In both cases, bio-based plastics can behave like ordinary plastics in the real world, persisting for years when littered and contributing to microplastic pollution as they fragment into smaller pieces.

In most cases, bio-based plastics mirror the function and end-of-life behavior of conventional plastics, and therefore do not help reduce plastic waste or plastic pollution. The main purported benefit of bio-based plastics is that they are made from renewable materials (agricultural products) instead of fossil fuels. However, most bio-based plastics also contain fossil fuel-based materials, which can in some cases make up as much as 75% of the product.[46]



Source: Break Free From Plastic

[46] Surfrider Foundation Europe (2020) ; Eunomia, *Relevance of Biodegradable…* (2020) ; Álvarez-Chávez, C.R., and al. (2012).

Even when constituted 100% of biological feedstocks, it is important to understand that the environmental impact of bio-based materials is highly dependent on the land-use and agricultural practices used in growing them. Some life cycle analyses show that bio-based plastics can be just as harmful or even worse than conventional plastics when it comes to energy use, climate change, air pollution, and ecotoxicity.[47] This is partly due to the fact that the agricultural products used to make bio-based plastics (corn, potatoes, sugarcane) are rarely farmed sustainably. The water, energy, pesticides, and fertilizers used for the typical, commercial farming of these products make the process highly resource-intensive, and undercut the potential sustainability of bio-based plastics.

If bio-based plastics replaced conventional plastics completely, this reliance on agricultural inputs would become an even bigger problem, demanding as much as 7% of global arable land to produce the necessary crops.[48]

Competition for land between bio-based plastic feedstocks and food crops could potentially drive food costs up,[49] and could further incentivize the conversion of forests to agricultural land around the world. Moreover, these plastics are not necessarily safer just because they are based on natural, biological sources. Many bio-based plastics are inherently toxic, generate toxic byproducts during production, and/or contain toxic additives.[50]

Overall, bio-based plastics are clearly not a more sustainable alternative to conventional plastics, and have no role to play in solving the plastics crisis.

BIODEGRADABLE AND COMPOSTABLE PLASTICS

Biodegradable plastics are plastics that can be broken down by microorganisms like bacteria and fungi into water, carbon dioxide, and other molecules found in nature. They can be made from conventional, fossil fuel feedstocks, biological feedstocks like potato starch, or both.

"Biodegradable", therefore, refers to end-of-life behavior, regardless of the materials used to make the plastic. Different biodegradable plastics require different amounts of heat, oxygen, moisture, and sunlight to actually break down into organic materials. Depending on environmental conditions, biodegradable plastics may or may not break down as intended, and evidence suggests that under many circumstances they fail to do so in a reasonable amount of time in the real world.[51]

Compostable plastic is a type of biodegradable plastic that is certified to break down under specific conditions, like those of an industrial composting facility. In this way, all compostable plastics are biodegradable, but not all biodegradable plastics are compostable.

Laws in the European Union or the USA set requirements for a plastic material to qualify as compostable, including inherent biodegradability, a test on compostability in operational conditions, and a guarantee that the material is free of dangerous levels of heavy metals and does not negatively impact compost quality.

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[47] Walker, S., Rothman, R. (2020).
[48] Raschka, A., and al. (2013).
[49] Popp, J., and al. (2014).
[50] Álvarez-Chávez, C.R., and al. (2012) ; Zimmerman, L., and al. (2020).
[51] Haider, T., and al. (2018) ; Napper, I., and al. (2019) ; Nazareth, M., and al. (2019) ; UNEP (2015).

A few countries (e.g. France) have adopted standards for "home-compostable" plastics, which require degradation to occur at a lower temperature, but the potential benefits of such standards are limited by consumer access to well-managed compost piles, varying temperatures across climate zones, consumer confusion about home vs. industrial composting certification, and a lack of international consensus on testing criteria.

Substituting conventional plastics with biodegradable plastics[52] would not help reduce plastic waste, and could even hamper current waste recovery efforts. Neither compostable nor biodegradable plastics are intended or well-suited for reuse, as they are designed to degrade more readily than conventional plastics. For this same reason, biodegradable plastics can reduce the quality of mixed recyclable materials,[53] and are sometimes considered contaminants in recycling systems. When composted, non-compostable biodegradable plastics are not guaranteed to break down completely, and can leave behind partially degraded fragments and microplastics in the resulting compost.

When littered in the open environment, biodegradable and compostable plastics can be just as problematic as conventional plastics. Many studies show that biodegradable plastics fail to fully biodegrade in real world environments, and can remain intact for years before fragmenting into equally persistent microplastics.[54] This is particularly concerning given the common perception that biodegradable plastics are "eco-friendly" and can biodegrade naturally. While consumer behavior related to biodegradable plastics has not been studied extensively, one report on the littering behavior of Los Angeles residents suggests that consumers may be more likely to litter biodegradable items.[55] When biodegradable plastics end up in landfills, they get buried in other waste, where they can form methane as they decompose.[56]

However, we should mention that, in limited circumstances, certified compostable plastic bags can be useful for improving waste management systems. In places that collect food waste separately for industrial composting, the use of certified compostable plastic bags as liners for food waste bins can improve participation in food waste separation, make collection by waste management companies easier, and increase the processing efficiency of composting facilities where bags no longer need to be split and sorted out from organic waste.[57] And while reduced plastic usage and product reuse is almost always the best waste management strategy, in cases where single-use plastics are unavoidable, such as during disaster relief operations or for plastic straws that people with certain disabilities depend on for drinking, compostable plastic could be an acceptable alternative to conventional plastic.[58]

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[52] Other biodegradable alternatives, like bags made from natural fibers, have been used in many countries long before the advent of plastics, and are becoming more popular among zero waste advocates as more sustainable alternatives to plastics.

[53] Samper, M., and al. (2018) ; Alaerts, L., and al. (2018).

[54] Haider, T., and al. (2018) ; Napper, I., and al. (2019) ; Nazareth, M., and al. (2019) ; UNEP (2015).

[55] S. Groner Associates (2009).

[56] Eunomia, *Relevance of Biodegradable…* (2020).

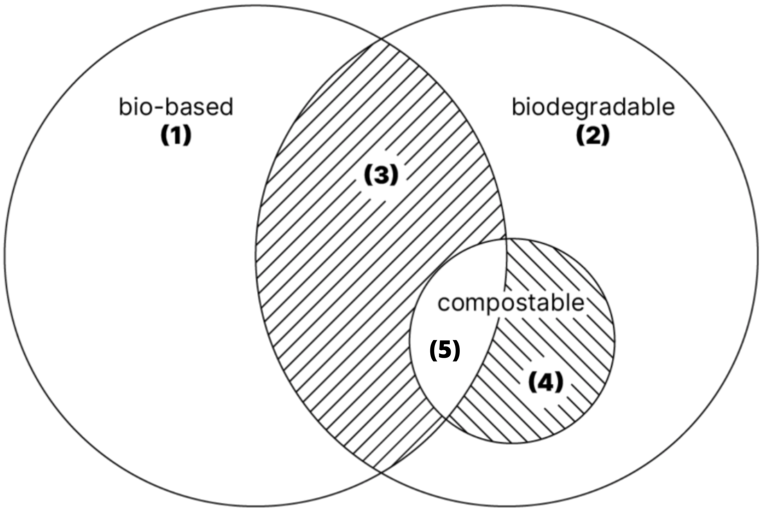
[57] Breton, Tony.

[58] Although in the case of drinking straws for disabled people, conventional plastics might sometimes be the most appropriate option, as compostable plastic straws can melt or break apart when used with hot drinks.

But all other applications of compostable plastics such as single-use packaging still raise the many issues we previously discussed, so outside of the specific uses of compostable plastics as food waste liners or last-resort materials where reusable products are not available or appropriate, compostable and biodegradable plastics should not be looked to as substitutes for conventional plastics.

CONCLUSION ABOUT BIOPLASTICS

As shown in the diagram below, bioplastics can be **(1)** bio-based but not biodegradable, **(2)** biodegradable but not bio-based or compostable, **(3)** bio-based and biodegradable but not compostable, **(4)** compostable and biodegradable but not bio-based, or **(5)** bio-based, biodegradable, and compostable.



Source: Break Free From Plastic

In any case, it appears very clear that bio-plastics, regardless of what is truly meant behind this ambiguous term (and despite very few specific usages of compostable plastics), are not the sustainable, green alternative to fossil fuel-based plastic that most people think they are.

OXO-DEGRADABLE PLASTICS

Oxo-degradable plastics are not to be confused with biodegradable plastics. They are conventional, fossil fuel-based plastics mixed with additives that can accelerate the material's breakdown into smaller pieces when exposed to sufficient sunlight, oxygen, and/or heat.

Real world conditions, however, do not always allow for this fragmentation to happen, and oxo-degradable plastics sometimes remain intact for years when littered in the open environment, resulting in the same catastrophic ecological impacts as conventional plastics. When they do successfully fragment, oxo-degradable plastics simply undergo an expedited process of breaking into smaller and smaller fragments, contributing to microplastic pollution rather than becoming organic matter like biodegradable or compostable plastics. In countries that do not have or do not enforce labeling standards, some oxo-degradable plastic companies make misleading claims that their products are biodegradable, compostable, or good for the environment, but it is simply not true.

Substituting oxo-degradable plastics for conventional plastics neither contributes to circular economic goals nor reduces plastic waste and pollution. Moreover, their inherent property to fragment into very small, but not ultimately biodegradable, pieces, makes them intrinsically dangerous to wildlife, the food web, and human health.

By design, the additives in oxo-degradable plastics make them less durable than conventional plastics, limiting their suitability for reuse and potentially reducing the quality and economic value of mixed recyclable materials when they end up in recycling systems.[59]

As for their impact on plastic pollution, oxo-degradable plastics are intended to reduce the buildup of plastic waste in the open environment by quickly fragmenting into smaller pieces. However, evidence suggests that in real world environments where exposure to sunlight, oxygen, and heat varies, oxo-degradable plastics often fail to fragment as quickly as intended, sometimes persisting for years as litter.[60]

When fragmentation does occur, the resulting small fragments and microplastics become difficult or impossible to collect, guaranteeing that the material will stay in the environment, where it can have toxic effects on surrounding wildlife.[61] Moreover, the accelerated fragmentation of oxo-degradable plastics means that microplastics are formed more quickly and build up in a shorter period of time compared to conventional plastics.[62] A shift to oxo-degradable plastics, therefore, would result in more, not less, microplastic pollution.

Some studies suggest that this fragmentation can lead to at least partial biodegradation, that is, the breakdown of the material by microorganisms, under the right conditions.[63] However, there is no conclusive evidence that full biodegradation, i.e. final breakdown of such plastics into CO2 and H2O, occurs in the real world,[64] and numerous studies show that oxo-degradable plastics do not biodegrade even years after fragmenting.[65]

In this way, use of oxo-degradable plastics would not reduce plastic pollution, and could even make the plastics crisis worse. In fact, it is such as bad solution that it has already been banned in the European Union[66] and will probably be legally forbidden soon in other countries such as Australia.[67]

[59] Hornitschek, B. (2012) ; Aldas, M., and al. (2018) ; Greene, J. ; Eunomia (2016).

[60] Eunomia (2016) ; Mclauchlin, A., Thomas, N. (2012) ; California Integrated Waste Management Board (2007) ; Feuilloley, P., and al. (2005).

[61] Schiavo, S., and al. (2020).

[62] Eunomia (2016).

[63] Eunomia (2016) ; Yashchuk, O., and al. (2012).

[64] Eunomia (2016) ; UNEP (2015).

[65] Feuilloley, P., and al. (2005) ; Briassoulis, D., and al., *Analysis of long-term degradation behaviour…* (2015) ; Briassoulis, D., and al., *Degradation in soil behavior…* (2015).

[66] Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019.

[67] Australian Department of Agriculture, Water, and the Environment (2021).

PLASTIC CREDITS

A plastic credit is a tradable certificate that represents a certain amount (often one metric ton) of plastic waste that has been recycled, recovered as litter from the open environment, or prevented from entering the environment.

Credits are generated by projects that physically recover or prevent plastic waste, and are bought by companies that want to offset, or balance out, the plastic waste that they generate. For example, a company that produces single-use plastic water bottles in the USA could buy credits from a plastic "offset project" in the Philippines that uses the credit income to provide waste pickers with better equipment that allows them to collect more plastic waste, or a project that directly pays waste pickers in India to collect low-value plastic that would otherwise not be worth collecting. In this way, plastic credit buyers pay for the waste reduction efforts of credit generators, without necessarily reducing the amount of plastic waste they produce. Companies may use these credits as justification for claiming "plastic neutrality" or that they use "50% recycled plastic," giving the impression that they have reduced the amount of plastic waste that they produce (or the part of it that ends up in the environment).

The plastic credits market is quite new, however, and there is no single, globally-codified standard for determining how a credit is defined, approved, generated, verified, or tracked. Instead, dozens of organizations have launched services aimed at the emerging plastic credits market, each with their own set of definitions and standards. This has resulted in an entirely privately-run plastic credits market, where private entities establish all the rules.

Plastic credits do not reduce plastic production, and therefore do not contribute to a solution to the plastics crisis. At most, they are intended to balance out the plastic waste generated by credit buyers, allowing pollution in one location to continue as long as it is offset by reductions somewhere else.

This plastic "neutrality" gives waste generators – often large, consumer-facing companies – an eco-friendly image to market to consumers, without actually reducing the amount of plastic waste produced. This allows plastic producers to continue unsustainable practices while shifting responsibility to others. This effect, often called "greenwashing", obscures the role that credit buyers play in producing plastic waste in the first place and erodes public pressure for solutions to plastic waste production.

In addition to these conceptual flaws, plastic offset projects face significant implementation challenges, including how to establish "additionality", match the impact of offset projects to the impact of waste production by credit buyers, and avoid creating new environmental or social problems.

"Additionality" is the principle that any plastic waste recovered or prevented through an offset project should be additional to all efforts that would have happened anyway if the project had never existed. In international carbon credit markets, which have served as the model for plastic credit markets and where credits represent carbon dioxide emissions instead of plastic waste, additionality was the source of intense debates. Its assessment led to significant delays in offset project approval, and was a major driver of the poor performance of the carbon market set up by the Kyoto Protocol's Clean Development Mechanism.[68]

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[68] Pearson, B. (2007) ; Petersen, B.V., Bollerup, K. (2012).

The current lack of agreed upon definitions or certification standards in the plastic credits market makes additionality an even greater challenge, and the lessons from carbon markets do not bode well for plastic credits. Additionality is vital to the functioning of a plastic credits market, but difficult to prove. That's because additionality requires knowing what would have happened in the absence of the program but didn't because the program exists. Income from plastic credits is a possible driver of plastic waste reduction or recovery programs, but it is certainly not the only one. A neighborhood volunteer group might want to prevent plastic bags from clogging up their storm drains, for example, or a local fishing association might want to reduce plastic pollution in the waters that its members depend on for their living. In such conditions, how do we prove that an offset project is the real or main reason plastic waste was reduced or recovered in a given area? It's virtually impossible.

Plastic credit programs also face the challenge of matching the impact of plastic pollution in the waste-generating location to the impact of waste recovery or prevention in the credit-generating location. There are many different types of plastic and plastic products, all with different physical and chemical properties that have different impacts in different environments. The recovery of one ton of plastic water bottles from an unmanaged urban dumping site, for example, might not balance out the risk to wildlife or microplastic pollution created by one ton of plastic soda rings littered in the ocean as a result of a credit-buyers' operations. An effective plastic credits market, then, requires a whole new level of analysis and verification to match the impacts of waste generation and waste recovery, further complicating the system.

Moreover, none of what we just explained precludes the possibility of new offset projects having direct negative impacts on their surrounding communities or environments. Projects that provide poor working conditions or insufficient wages, ignore human rights and other social safeguards, or compete with informal waste workers for plastic waste, for example, should obviously be avoided.

The current plastic credits market, however, offers no assurances towards that end. In the same way, there is no guarantee that plastic offset projects won't have other environmental impacts. By some definitions, credits can be generated for plastic waste that is recovered, but then incinerated, converted into refuse-derived fuels, or even disposed of in open dumps.[69] Nestle's Costa Rica branch, for example, claims to have achieved 'plastic neutrality' by recovering and burning enough plastic waste as fuel in cement kilns to 'offset' the plastic they produce[70] – although incineration is a terrible idea for people and the planet, as we explained above. As it stands now, the plastic credits market provides no guarantee that it will not create new problems where credit generation projects pop up.

Plastic credits could have further indirect impacts by establishing perverse incentives that discourage plastic waste reduction. A company that starts making money by collecting plastic litter for offset credits, for example, has a financial incentive to oppose a single-use plastic ban in their area. A manufacturer that generates plastic waste may postpone effective waste prevention activities because credits from an offset project may be cheaper. In other words, the very same financial incentives that can create an offset project intended to mitigate plastic waste pollution can also provide the incentives to keep the waste flowing. This exact issue has been observed in

[69] World Wildlife Fund (2021).

[70] Nestlé (2020).

carbon offset markets, and in some cases even led to increased greenhouse gas emissions at offset project sites.[71]

Finally, beyond the implementation challenges that offset projects face, the plastic credits market as a whole presents logistical and financial challenges. Already, dozens of actors are involved in the process of setting standards and definitions, developing offset projects, verifying these projects, creating credit-tracking systems, marketing credits, and brokering deals with buyers. Every link in the chain adds complexity and reduces transparency, resulting in a crisscrossed, international system that, as seen with carbon markets, is ripe for miscommunications, misrepresentation, and even fraud.[72] This in turn confuses and discourages consumers, reducing public pressure on companies to manage their plastic waste, and will require an incredible amount of regulatory oversight from both the private and public sectors, absorbing time and energy that could be spent on more effective solutions like actual plastic waste reduction.

Plastic credits are conceptually flawed, difficult to implement, and create a level of complexity that threatens to undermine other, real solutions to the plastics crisis. Therefore, they should not be encouraged.

CONCLUSION AND RECOMMENDATIONS

This scientific review of existing plastic 'solutions' brings a very clear conclusion: there is currently no real solution – in Mongolia like in the rest of the world – to properly manage and process the tremendous amount of plastic waste that we produce. As stressed above, recycling can be considered relevant to some extent, if adequately integrated within a well-thought broader plan, but it is widely insufficient in itself and comes with unavoidable problems and counter-productive effects of its own. Unfortunately, this review of other available techniques (waste-to-energy, bioplastics, plastic credits, and so on) shows that none of them is to be recommended.[73]

This conclusion emphasizes how critical it is to go back to and seriously take into account the fundamental '3R' rule of waste management: first, REDUCE waste production; then, REUSE unavoidable waste; finally, RECYCLE what is left. It is of paramount importance that decision-makers and policy planners keep in mind and respect this hierarchy of solution, instead of focusing only on the third and lowest level (recycling and other – bad – techniques reviewed in this report).

To that end, Ecosoum recommends 14 main measures that, if wisely adopted and enforced, could turn Mongolia into a virtually zero-waste country within just a few years. These measures are intended to address the waste crisis as a whole, and not only plastic waste – although plastics are definitely the most problematic type of waste we have to deal with today.

For clarity purposes, we divided our 14 main recommendations into 4 categories:
1. recommendations to reduce waste and improve reusing;
2. recommendations to enable effective recycling;
3. recommendations to improve waste management systems on the field;
4. recommendations to enable financial sustainability of our waste management systems.

[71] Schneider, L., Kollmuss, A. (2015).

[72] Badgley, G., and al. (2012) ; Pearse, R., Böhm, S. (2014) ; Compensate (2021).

[73] With exception of compostable plastics in very few specific usages, as explained above.

RECOMMENDATIONS TO REDUCE WASTE GENERATION AND INCREASE THE POSSIBILITY OF REUSING

1. All disposable products and packaging (both single-use and short lifespan items) **must be strictly and immediately banned** to reduce waste generation. All industries, starting with food and beverages companies,[74] must systematically switch to reusable packaging and organize reusable packaging take-back. For instance, it means that drinks like sodas should not be sold anymore in single-use plastic bottle, but should be marketed in reusable glass bottles, as it was the case just a few decades ago.[75] This is the only way to put an end to our throw-away society and finally embrace a zero-waste circular economy.

2. Packaging should be standardized by type of product for all companies and brands, to facilitate reusing processes (take-back, refill, etc.). Imagine how easy waste management could become if all drink bottles, all yogurt pots, all shampoo containers, had the same standardized dimensions. They would be so much easier to sort, clean and refill. Sure, advertising would be more complicated for brands; but, after all, would it be such a bad thing if people stopped being brainwashed all the time by the advertising industry? Are we buying products because they are quality and we truly need them, or are we buying them because the packaging looks so nice that we can't resist compulsive consumption? In any case, marketing issues are secondary and should always come after ecological and sustainability considerations.

3. Local goods production and shorter supply-consumption chains must be enabled and supported to reduce the need for packaging. If today our food and goods need so much wrapping, it is because most products travel the world in all directions and stay on shop shelves for weeks and months. So, of course they need a lot of 'protective' packaging. But if we produced and consumed our fresh food and quality goods more locally again, we wouldn't need so much packaging, and we wouldn't generate so much waste. It is important to emphasize that this switch would recreate many local jobs for unemployed people, especially in the countryside, which in turn would contribute to alleviating the socio-economic and environmental problems linked with overpopulation in Ulaanbaatar. In this perspective, supporting local cooperatives and local products would greatly contribute to solving both unemployment and waste-related problems.

4. While companies adapt their practices to reduce packaging and waste, **the population must also change its consumer habits**. We must consume less to generate less waste. And we must consume 'better', which means favoring long-lasting repairable products, sold without any useless wrapping, or with reusable packaging. As consumers, our choices alone are clearly not sufficient to change the world for the better; but our consumption patterns do send signals to companies. National policies should provide incentives for people to reduce over-consumption, or at least take measures against overwhelming advertisement that push people to over-consume and produce unmanageable waste.

[74] According to Ecosoum's audit, up to 90% of household waste to be managed is actually food or beverage packaging, which means either bottles, jars, or different kinds of wrapping. See Ecosoum's "*Who Produces Our Waste?*" brand audit report (2022).

[75] Ecosoum, *Zero Waste And Circular Economy: The Way Forward* (2021).

RECOMMENDATIONS TO ENABLE EFFECTIVE WASTE RECYCLING AT A SYSTEMIC LEVEL

5. Misleading uses of the word “recyclable” should be condemned and forbidden. We usually hear that a lot of our waste is recyclable, but very often it is actually not true, because recycling, especially for plastic, has many limits. If we want to enable effective, sustainable recycling, we must make a clear difference between true ‘recycling’ and what we call ‘downcycling’. For example, true recycling would mean turning an old PET bottle into a new one. With an old item, which has become waste, we make a new equivalent one: this way, we would close the loop of the circular economy and we don’t need additional virgin natural resources. But this rarely happens. Usually, PET bottles are turned into something like sweaters, carpets, or any other lower-grade product that will quicly end their life in a dumpsite. With this kind of ‘downcycling’, we do turn a piece of waste into something new, but this new thing is usually of lower quality and not recyclable itself. This is not sustainable. But unfortunately, in today’s Mongolia, we don’t recycle anything; we only *downcycle*. Therefore, the national legislation should strictly regulate the use of the words “recyclable” and “recycled” in order to avoid consumers to be confused or misled.[76]

6. When products and packaging can honestly not be avoided nor be made reusable, national policies must **set the right conditions for recycling to be possible**. This notably means to promote priority use of truly and effectively recyclable materials, and strictly ban non-recyclable materials when a recyclable alternative exists. Overall, the range and number of materials used by packaging industries must be reduced, especially in terms of plastic types, and these few materials must be standardized to facilitate recycling processes. Designs that make effective recycling extremely complicated even when each of the materials that are used are theoretically recyclable – like multi-layer or multi-material packaging – must also be forbidden. Tetra Paks are a good example of this issue. They are made of carton, plastic and aluminum: in theory, all these materials are recyclable, but in practice no one can really recycle Tetra Paks, especially in Mongolia, because it is too complicated and expensive. Likewise, single-use sachets, which are not recyclable and are a terrible plague in Mongolia and all around the world, must be strictly forbidden.

7. Each **company should have the responsibility to collect their waste** (for instance, MCS should collect all its PET bottles, APU should collect its glass bottles, etc.) **and carry out by themselves effective reusing or recycling** of their waste (or find a subcontractor, if they prefer). True social responsibility of producers should imply that they are legally accountable and directly in charge of properly managing their waste rather than relying on the goodwill and efforts of others. It is not acceptable that large plastic producers let public administrations and small private recyclers take care of all the work, without any real support. If big polluters were accountable to recycle their waste, they would surely create the right conditions for effective recycling. But history shows that voluntary pledges and commitments by large corporations are more often used for greenwashing communication campaigns than followed by actual relevant actions. Therefore, public decision-makers should strictly reinforce the legal definition and effective enforcement of corporate ‘social responsibility’.

[76] As explained in Ecosoum’s *Zero Waste And Circular Economy* report, recent studies have shown that people tend to overconsume when they think - rightly or wrongly - that their product/packaging can be recycled.

RECOMMENDATIONS TO IMPROVE WASTE MANAGEMENT ON THE FIELD

8. Whether waste is reusable, recyclable or not really, one thing is sure: waste management systems and facilities need waste to be properly sorted. That is why **waste sorting should be mandatory and extensive for everyone**. This means not just for households at home, but also for all waste producers, especially industries, including in their production processes. We should always keep in mind that, on average, for each bag of garbage we generate at home, industries generated 70 more waste bags just to produce what is in our garbage bag.[77] It means that even if individuals perfectly sort their waste at home, most of the actual waste remains to be sorted by industries upstream. Waste sorting should be a legal obligation, not a mild suggestion.

9. Relevant companies should organize and/or facilitate transportation of their reusable/recyclable waste from generation areas (ger districts, soums and aimags) to processing areas (reusing and recycling facilities in Ulaanbaatar). We often hear public administration be blamed for waste collection systems not working properly: of course, they don't work properly, because proper waste collection is way too expensive and complicated for municipalities if polluting companies don't chip in and participate. Whether within UB or from soums and aimags to UB, the vehicles supplying consumer-goods to shops should be used to bring back the associated waste to reusing and recycling facilities. Large companies like APU, MCS and so on should coordinate amongst themselves to mutualize efforts and expenses, and in any case, they should not let municipalities take care of everything for them. Here again, public decision makers cannot wait for corporation to implement such transportation on a voluntary basis: it should be made mandatory by law.

10. Relevant companies must alleviate their strict take-back rules, which currently compromises the ability of field waste workers to do their job properly. For example: in Bulgan aimag, waste workers recently collected and sorted many vodkas glass bottles, for a total of 4 million tugruks according to the official purchasing prices claimed by the company. But when they brought the bottles to UB, the company paid only 90,000 tugriks, alleging that there were too many scratches. This is not acceptable, because waste workers spent a lot of time and money to properly sort and transport this waste, and they just lost everything. Next time they won't bother sorting and they will put everything in the dumpsite. Under these conditions, local waste management systems, especially in the countryside, cannot be sustainable. That is why, even if there are scratches or damages, companies should alleviate their rules and buy back all their waste, so that local-level waste workers can do their job properly without risking bankruptcy. Of course, companies cannot reuse damaged bottles, but it should be their legal responsibility to make sure the broken glass is properly recycled and not abandoned in a dumpsite. Incidentally, bringing the responsibility back to companies will incentivize them to improve the reusability of their bottles.

11. Relevant companies should transparently collaborate with local stakeholders (ger district and soum administrations, CSOs like Ecosoum) **in establishing pilot waste management systems** consistent with the above-mentioned recommendations. This way, the best solutions for all stakeholders can be designed and experimented, before scaling up and replicating in the entire country. Public policies should frame such pilot approaches to make sure companies actually scale up their local accomplishments within a reasonable timeframe.

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[77] Worldwatch Institute (1994).

RECOMMENDATIONS TO ENABLE FINANCIAL SUSTAINABILITY OF LOCAL WASTE MANAGEMENT SYSTEMS

12. Decision makers should **increase public budgets** dedicated to waste management at the soum-level and **facilitate introduction of dedicated local taxes and/or contributions**. Although the current National law on waste could significantly be improved following these recommendations, in theory it already offers a relatively relevant regulatory framework for the countryside as the State sets a lot of standards and demands for soum administrations to organize proper waste management. But soum budgets are so small that it is virtually impossible to respect the Law… If waste management is a priority for the State, public budgets should definitely be increased to match the Law's ambitions and expectations.

13. That being said, State public budgets are undoubtably limited and insufficient to solve all important problems. That is why **consumer-goods companies** that are at the origin of most waste (especially food and drink sector) **must contribute much more financially to support and balance local waste management budgets**. They should provide direct financial subsidies to khoroos, soums and aimags administration budgets. As I previously explained, companies should also systematize buy-back of all packaging from all their brands, whether it is reusable or recyclable and regardless of the condition, so that incomes from selling this sorted waste allows balancing local waste management budgets. And it is essential that these purchasing prices of recyclable/reusable waste are somehow indexed on gas prices and take into account distance between soums and purchasing points (so that financial sustainability is ensured even if gas price increases and even for remote soums). National legislation should ensure that companies dedicate a reasonable percentage of their incomes to supporting public waste management systems.

14. Adequate reusing and recycling plants should be set up at the aimag-level, instead of centralizing all facilities in Ulaanbaatar. We spend too much money and emit too much greenhouse gases sending all countryside waste to Ulaanbaatar by truck. If there were proper recycling plants in aimag-centers, everything would be much easier, faster, and cheaper. Decentralizing waste management should also mean set up more production industries in aimags, to facilitate packaging (reduction and) reusing. For instance, if APU had vodka factories and MCS soda factories at least in some aimag-centers throughout the country, it would be easier to collect reusable and recyclable bottles, and these bottles would not be damaged during long transportation to Ulaanbaatar. Incidentally, embracing such a decentralizing approach would also recreate jobs in the countryside, and alleviate the demographic pressure on the over-crowded capital city. Everybody wins – even if it means that large companies make a little less profit for their shareholders.

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