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October 2017

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Towards circular plastics

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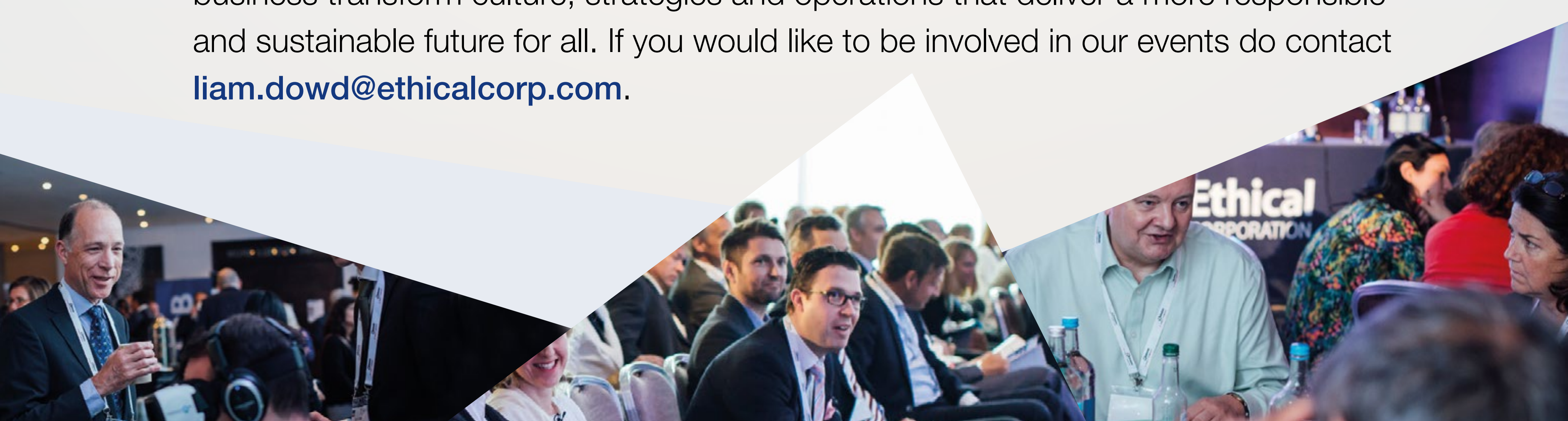

Editor's letter

Welcome to the October 2017 issue

The naturalist David Attenborough has added his voice to ever-louder warnings over crisis levels of plastic pollution in the world's ocean, saying that his second series of Blue Planet will feature scenes of albatrosses returning to their chicks after weeks away gathering food with only plastic to feed them.

Brands are coming under intense pressure to act, particularly given that the bottles and plastic packaging washing up on pristine tropical beaches bear the names of brands that have taken greatest leadership on sustainability, including Unilever, P&G, Nestlé and Coca-Cola. This month expert science journalist Angeli Mehta looks at the latest innovations in sustainable packaging solutions, both in decreasing plastic waste, and in finding alternatives to fossil-fuel polymers, and asks what it will take to bring these to scale.

Our second briefing is about the garment industry, and how brands are responding to the growing demands for greater transparency on social and environmental issues. Nadine Hawa reports on how a new digital initiative to map the Bangladesh garment industry could help redress a failure to increase transparency in the wake of the Rana Plaza tragedy. Rebecca Ley looks at consumer apps that are harnessing the power of millennials to press for better conditions for garment workers, and Angeli Mehta reports on the environmental devastation caused by viscose production, and what it will take for the fashion industry to clean up its act.

Next month, with COP23 happening in Bonn, we delve into green finance and business action on climate change.

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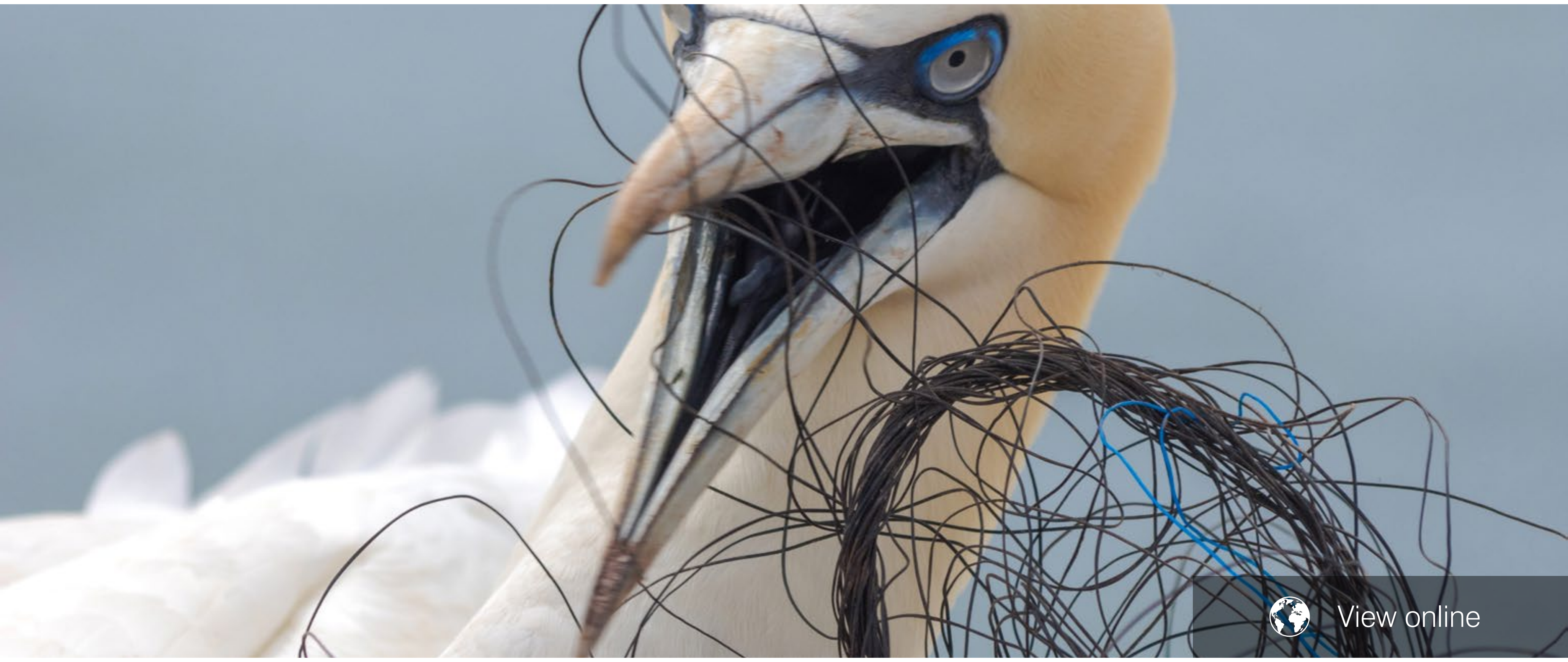

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Brands wake up to tragedy of the oceans

By Angeli Mehta

Shocking images of marine life choking on plastic waste are finally moving companies to innovate on more sustainable packaging solutions. But can we kick a decades-old addiction?

Plastics are indispensable to modern life, yet our careless discarding of them is choking our oceans and doing untold damage to marine life. And to ourselves.

According to the Ellen McArthur Foundation, 8 million tonnes of plastic a day is dumped into our oceans, and by 2050 there will be more plastic than fish by weight. Once in the ocean, plastic absorbs toxins and breaks down into tiny pieces, which find our way into our own food chain.

Only 20% of the 300 million tonnes a year of plastics produced is recycled. As CDP's recent Catalyst for Change report points out, plastics production is one of the chemical industry's highest greenhouse gas emitting processes, and more than a quarter of plastics production is used for packaging. If plastics are to have a future we will need to be able to recycle them back into valuable products time and again, and we will need to find new ways to make them.

The shocking images of oceans awash with waste that will be floating around for hundreds of years are beginning to have an impact. As the CDP report's authors ask: Is this going to be the 'diesel moment' for the plastics industry?

Earlier this month Andy Clarke, former boss of Asda, called on supermarkets to stop using plastic packaging altogether, and for the UK packaging industry and supermarkets to "work together to turn off the tap".

Coca-Cola is estimated to make 110bn single-use plastic bottles every year, more than half of which don't get recycled

Some brands are trying to engage consumers by putting recycled marine plastics into their packaging (see P&G's recycling message in a bottle to consumers); they and others have pledged to expand their use of recycled materials, and make more, if not all, of their packaging recyclable.

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Coca-Cola makes 110bn single-use bottles a year

Scale needed

Sky says it will ban all single-use plastics in its products, operations and supply chain by 2020. If followed through, such initiatives will cut both waste and the burgeoning carbon emissions from plastics production. The scale is immense: consider Coca-Cola, which is estimated to make 110 billion single-use plastic bottles every year – more than half of which don't get recycled. Australian NGO Boomerang Alliance estimates that one-third of marine litter is drinks bottles.

Many promising technologies are emerging from start-ups, but development takes years and without investment it's a struggle to get to scale. Without scale they can't challenge the old order of petroleum-based plastics, which are now so cheap to make, thanks to rock-bottom oil prices.

Too valuable for landfill

Waste processors want to know there's a guaranteed market for a recycling stream, and until enough material can be processed, that can't be proven either.

Plastics are too valuable to be sent to landfill. The manufacturers' association Plastics Europe calculated that if all plastics waste were to be diverted from landfill by 2025, an extra 5 million tonnes of plastic would be available for recycling every year. Plastics that couldn't yet be recycled would be used for energy recovery. It estimates that this route would provide energy for 30 million people, and would save 70 million barrels of oil used in industrial processes, such as cement making. It also suggests up to 300,000 jobs would be created.

Nine European countries have a landfill ban in place: recycling rates are a little higher there but more plastics waste gets burnt for energy than is recycled. While "energy recovery" avoids the use of fossil fuels it can only be done once, and it still releases CO_2 into the atmosphere, and potentially toxins too.

While energy recovery avoids the use of fossil fuels it can only be done once, and it still releases CO_2 into the atmosphere, and potentially toxins too

In fact, a European Commission communication on energy to waste concluded that the practice is "inconsistent with more ambitious recycling targets".

What will make the difference? Perhaps policy is needed: but which carrots and which sticks will be effective? Charging for single-use plastic bags made a difference almost overnight.

Last month the Scottish government pledged to introduce a deposit-return scheme for bottles and cans, and more recently Defra has set up a working group to examine how such a scheme could run in England.

"We could look at metrics other than weight," suggests Carlos Palafox-Ludlow, one of the founders of Enval, which recycles plastic aluminium laminates. "We could better channel investment if we looked at the carbon locked up, and [the energy] .... it took to produce the item in the first place."

THE 5 GYRES INSTITUTE

Plastic pieces found on a beach

Consumers action needed

Tom Szaky, co-founder of Terracycle, the New Jersey company that made its name tackling hard-to-recycle materials, suggests subsidies could help recyclers compete. However, consumers need to play their part both by recycling and "choosing products that try to make a difference," Szaky says.

The naturalist and filmmaker David Attenborough added his voice to the global call for urgent action earlier this month when he launched his second series of Blue Planet, which will feature distressing scenes of albatrosses spending weeks away from their chicks gathering food, and returning with bellies full of nothing but plastic.

"What we're going to do about the 1.5C rise in the temperature of the ocean over the next 10 years, I don't know," he told one interviewer. "But we could actually do something about plastic right now."

On the following pages, we look at the current state of innovation to tackle this issue and the challenges to scaling up new technologies to improve plastics recycling and make plastics from renewable materials. ■

'I don't know what we can do about the 1.5C rise in ocean temperatures, but we could do something about plastics right now'

View online

BIEL CALDERON/GREENPEACE

Who's bending the curve on reusing plastic?

By Angeli Mehta

With increasing attention drawn to their packaging washing up on pristine beaches, brands are setting stretch targets to get their materials back. We look at potentially game-changing technologies to close the loop, and the challenges of deploying them when the economics do not yet stack up

Recovering the value of plastic when it's been used means we must get better at sorting waste. The purer each recycling stream, the better the quality (and value) of the recovered plastic.

Materials-recovery centres use near infrared optical sorting systems to identify different polymers, but they can't distinguish plastics suitable for food storage, identify what's under a shrink-wrap sleeve or recognise black plastics, so they all end up in landfill. The pigment used in black plastics is carbon black. Its value is in the protection it offers from sunlight. But if that isn't required, using an alternative organic pigment would allow 70,000 tonnes of black plastic to be reclaimed annually in the UK – and some 500,000 tonnes across Europe – according to Edward Kosior, managing director of recycling consultants Nextek.

Ioniqa's process produces just 30% of the CO_2 of PET made from the usual petrochemical feedstocks

Prism

"Marker technologies are a cornerstone project for achieving a plastics circular economy," he says. His firm is leading a UK-funded project, Plastic Packaging Recycling using Intelligent Separation Technologies for Materials (Prism), to develop novel fluorescent markers using various materials such as waste powder from fluorescent lights and tubes, and metal oxide nanoparticles. The markers can be invisibly applied to labels, and removed and recovered before recycling. Kosior says they're able to separate out various categories of food grade and non-food grade plastics with 98% accuracy. A fluorescent marker system could allow 165,000 tonnes of polypropylene (used in meat trays and bottles) to be recycled to food-grade standards in the UK; across Europe, as much as 1 million tonnes could be recycled.

NEXTEK

Nextek's technology could boost recycling rates

Kosior is confident that the economics of labelling stack up. Costs are currently €1 (89p) per tonne of packaging, but that will come down. What's required is to retrofit existing sorting equipment with the necessary illumination and software, allowing consumer brands to potentially develop closed-loop recycling for their packaging. Sustainability commitments by the likes of Unilever and Procter & Gamble "mean they want their materials back", Kosior says.

Another important influence on the value of reprocessed plastics is how often they've been recycled, as this impacts on polymer properties. Nextek is awaiting patent approval for another marker technology that will allow recyclers to determine how many processing cycles a polymer has gone through.

'There's a lot of inertia in the system. People prefer to be fast followers rather than innovators'

CLIPP+

Another task is to strip contaminants and odours from plastic waste. An EU consortium, CLIPP+, found it was almost impossible to remove inks from printed plastic film because ink manufacturers make particles so small that they can't be filtered out. But they did find that the solvent they used, CO_2 as a liquid (so-called supercritical CO_2), was extremely efficient at stripping out odours, and could remove some colours. So whereas a lorry-load of reclaimed printed films (being used for despatch bags for eBay or Amazon, for example) has "quite a smell", the film could be used for more valuable products if the odour can be removed, explains Alan Heappey, project manager at UK packaging manufacturer Skymark. Reprocessed polyolefin films could, for example, replace virgin film as wrapping for pallets of toilet roll destined for supermarkets.

Ioniqa

Ioniqa Technologies, a spin-out from the Eindhoven University of Technology, has had more success removing contaminants from PET (polyethylene terephthalate) which is mainly used for textile fibres, and drinks bottles. But, significantly, when PET is added to the magnetic smart liquid that Ioniqa has developed, and then heated, the PET depolymerises. The colourants and other contaminants are removed in a magnetic field, to leave the original building blocks of the polymer.

Those building blocks can be used to create new PET, over and over again. That's a big advantage, because at the moment PET can only be recycled up to six times.

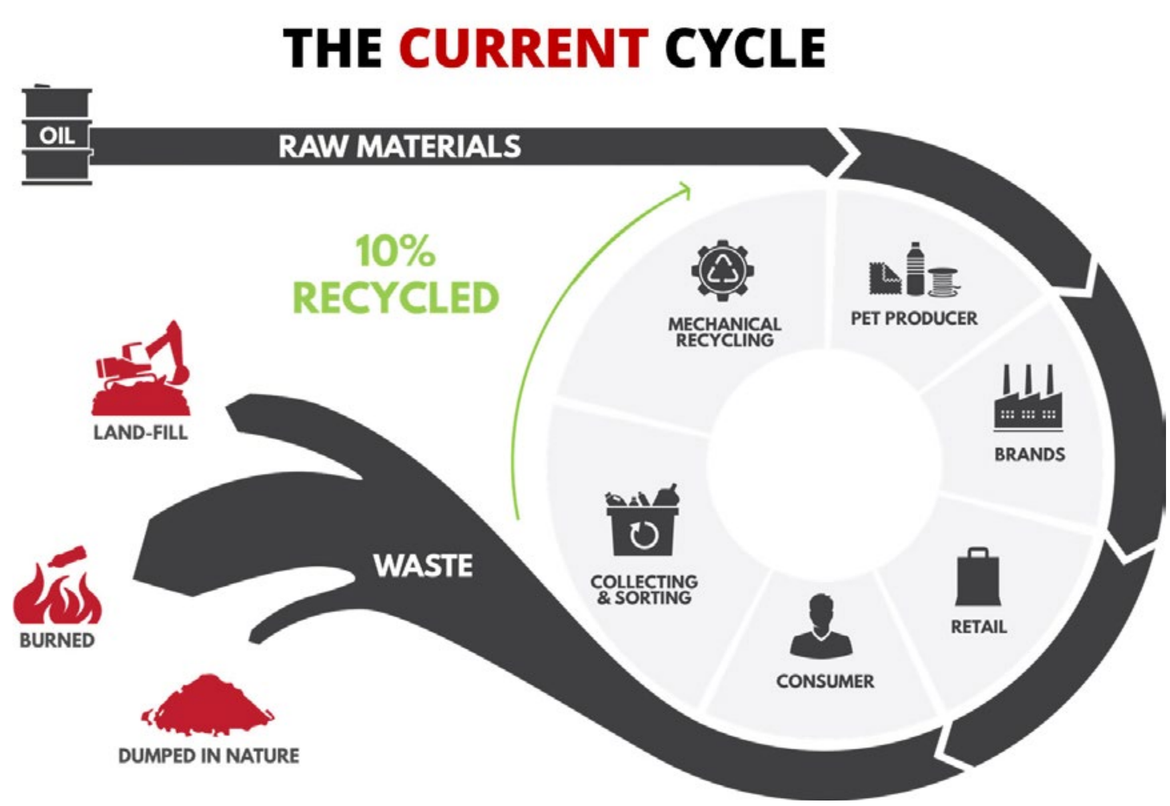
Ioniqua's founder, Tonnis Hooghoudt, describes it as a "game-changing technology that enable[s] a profitable, circular process for almost a quarter of all plastic waste in the world". Some initial testing has also found that the process could potentially be applied to other plastics, as well as cotton and paper.

Ioniqa's process produces just 30% of the CO_2 that would otherwise be the case if 1kg of PET were made from its usual petrochemical feedstocks. That's ignoring the further carbon cost if the PET is incinerated, which happens on a large scale around the globe.

But PET producers and consumer brands took some convincing, so Ioniqa invited some big brands to bring it their waste and then test out the resulting product in the brands' own labs. The ambition now is to scale up, with a 10,000-tonne production plant anticipated by the end of 2018 – if Ioniqua can convince potential customers.

A Greenpeace plastics audit on a Philippines beach found Nestlé, Unilever and Procter & Gamble were amongst the biggest polluters

IONIQA



Although PET bottles can be recycled, only 10% are

Dow

Even if it's technically difficult to separate certain types of plastics (such as those from electronic gadgets) or just not economical, they still might be recycled. Dow Chemicals (amongst others) has developed what are called combatibilsers, that allow two types of resins which wouldn't otherwise mix evenly to be recycled together. That way, the properties of the plastics (eg mechanical strength) can be maintained.

JILSON TIU/GREENPEACE

A waste audit by Greenpeace activists on a Philippines beach last month

It's evolved its RETAIN technology to help tackle one of the biggest recycling headaches: multi-layer food pouches with an inner barrier film.

Dow has built the modifier into a pouch, which can be recycled. To demonstrate its potential, Dow worked with flexible packaging manufacturer Bemis and converter Polykar to recycle multi-layer film scraps into plastic bags, which were used during Ocean Conservancy's coastal clean-up last month. It's now working on expanding the technology to enable different pouch mixtures to be recycled.

Jeff Wooster, global sustainability director for Dow Packaging and Specialty Plastics, is optimistic the technology will soon be commercialised. But he adds: "There's a lot of inertia in the system .... people prefer to be fast followers rather than innovators."

'Landfill is still very cheap, and without policies to divert waste from landfill, the investment won't come'

Unilever

Such solutions to enable recycling of multi-layer packaging are urgently needed, because while they may take less energy to manufacture and transport, they usually end up in landfill, or floating in the oceans.

Last month, Greenpeace released the results of a plastics audit along a stretch of beach in the Philippines: Nestlé, Unilever and Procter & Gamble were amongst the biggest polluters. Much of their waste turned out to be sachets, made of plastic film and aluminium foil. Billions of them are sold each year in developing countries, where they allow poorer people to buy small quantities of otherwise unaffordable products.

Unilever's own analysis has found that more than 60% of plastic flexible packaging in landfills in Indonesia (a country that produces 64 million tonnes of waste every year) is made of polyethylene (PE), so that's what it has decided to focus on in that country. Unilever has a worldwide commitment to ensure all its plastics are reusable, recyclable or compostable by 2025.

'What is missing is the solid business case for change that will create a waste processing infrastructure'

It has worked with Germany's Fraunhofer Institute for Process Engineering and Packaging to adapt a solvent technology to recover the PE, which Unilever claims is functionally equivalent to virgin polymer. The remaining layers – PET and aluminium – can also be recovered. According to the Fraunhofer Institute, the CreaSolv process can produce 6kg of recovered plastic using the same amount of energy as it takes to make just 1kg of virgin polymer.

To establish the commercial viability of the process, Unilever says it will build a pilot plant in Indonesia and, once proven, will make the technology available to its competitors.

The commitment to tackle sachet waste echoes a similar pledge Unilever made back in 2012, to build pilot plants in India to turn the waste into fuel, and so recover some of its embedded energy.

At that time Unilever said: "As part of the Unilever Sustainable Living Plan we have committed to developing and implementing a sustainable business model for handling our waste sachets by 2015."

Asked about the pyrolysis technology, a Unilever spokesperson said "this is not an established technology and has several limitations, making it difficult to develop and scale up a sustainable business model." The CreaSolv technology would, she said, counter this.

IONIQA

Ioniqa's process would allow PET to be recycled indefinitely

Enval

Enval, a Cambridge university spin out, has come up with a process to recycle plastic/aluminium laminate waste. 160,000 tonnes of it is produced each year in the UK alone, and the bulk goes to landfill. This is especially wasteful because making aluminium requires vast amounts of energy. Enval uses a microwave pyrolysis process that enables it to recover the aluminium at a very high purity, and save 75% of the energy that would otherwise be required to produce it.

The plastic melts to produce gas and oil; the gas can be used to generate electricity to run the process, and the oil sold for fuel or feedstock for speciality chemicals. Thanks to financial backing from brands including Nestlé and Mondelez, Enval has one plant at commercial scale, handling 2,000 tonnes of pre-consumer waste a year.

Chief executive Carlos Palafax-Ludlow says the UK generates enough to feed three such plants. But he despairs of the difficulties of getting the waste industry interested in post-consumer waste. “Landfill is still very cheap, and without policies to divert it [waste] from landfill, the investment won’t come.”

Ceflex’s goal is to set up an infrastructure for post consumer flexible packaging across Europe

Few local authorities collect such waste, which completes the vicious circle. But while the waste processors don’t care whose name is on the packet, Palafox-Ludlow believes the brands “have a vested interest in us being successful.”

While Enval has only one plant, it has plans for more, and could have one in every European country if it licensed the technology.

ENVAL

Enval’s process recycles plastic/aluminium laminate waste

Ceflex

So how can the inertia be overcome? Dow used some of what it learned as part of an Innovate UK project, which aimed to provide guidance on designing for recycling. The project evolved into Ceflex, a far more ambitious project whose goal is to see a collection, sorting and reprocessing infrastructure for post-consumer flexible packaging across Europe. It involves all players in the value chain: material producers like Dow, together with packaging converters, brand owners and retailers (like M&S); and recyclers. “What is missing is the solid business case for change [that will] create a waste processing infrastructure,” says Dana Mosora, one of the project management team. Ceflex, she says, will “come up with technical solutions and pilot projects that will provide the data” to make the case. Then it will be up to industry to advocate.

Achieving the big eye-catching commitments that brands are making on sustainability may very well depend on their success. ■

P&G sends recycling message to consumers with ocean plastics bottles

Procter & Gamble is using its iconic brands to try to change consumer behaviour and stem the flow of plastics into our oceans. It announced this month that it is working with New Jersey-based recycling experts TerraCycle to make bottles for its Fairy washing up liquid with 10% ocean plastic and 90% post-consumer recycled plastic.

In January it launched a Head & Shoulders shampoo bottle in France made with 25% beach plastic. "It's a way to create awareness that people can do something," says Virginie Helias, P&G's vice-president for global sustainability.

As a result of the recycled materials used, both bottles look slightly different from conventional plastic counterparts, a decision that wasn't taken lightly, she adds. But Helia hopes consumers will get the message that "now it's your turn to recycle."

PROCTER & GAMBLE

P&G has committed to doubling its use of recycled plastic in packaging

Tom Szaky, TerraCycle's founder, said it took a "tremendous amount of R&D to make sure the bottles are recyclable in a local authority programme." His company has tackled hard-to-recycle items by getting funding from big brands to solve the current economic challenge of recycled plastics being more expensive than conventional plastics, due to rock-bottom oil prices.

Other firms using ocean plastics include Adidas, which has worked with environment agency Parley for the Oceans to make a range of running shoes, where the upper is constructed using knitted yarn made from plastic waste collected around the Maldives, and the soles from other recycled plastics.

The shoe is the result of efforts to create a new supply chain for ocean plastic.

P&G has committed to doubling the amount of recycled plastic in its packaging by 2020, and is over 65% of the way to meeting that target. However, quality and supply of recycled plastic is an issue in developing regions of the world, so P&G wants to work with industry to help establish the necessary sorting and recycling infrastructure.

It made its announcement at an EU Ocean Conservancy conference earlier this month,where an initiative to raise $150m for waste management and recycling solutions in SE Asia was launched. Ocean Conservancy estimates that almost half the plastic that gets into the oceans originates in just five rapidly developing countries: Indonesia, Philippines, Vietnam, Thailand and China.

Angeli Mehta

SANTANOR/SHUTTERSTOCK

Can we scale up the new green plastics?

By Angeli Mehta

We assess the prospects of commercialising the latest generation of bio-based polymers, from those that store greenhouse gases to biodegradable PET

Plastics are made from non-renewable hydrocarbons like oil and gas, and expanding demand means the industry has a significant and growing carbon footprint.

There has been a huge research and development drive around the world to try to decouple production of plastics from fossil fuels. A lot of effort has gone into making plastics from biomass sources, and some of the new plastics being developed have properties that mean we will be able to use less of them in packaging.

Biopolymers are two to four times more expensive and will need a regulatory push

One thorny issue is that just because a plastic is bio-based doesn't mean that it will be biodegradable. Additives used in the final product may make it impossible for a plastic to biodegrade safely. In any case, it would still be better to recycle and reuse the bioplastic.

Another big challenge is that biopolymers can be anywhere between two and four times as expensive as fossil fuel-based polymers. "The main reason is small production volumes," explains Rob Elias, director of the biocomposites centre at Bangor University. So there's a big research effort to make biocomposites with increased functionality, such as those that improve food shelf life, for example.

Even with efficiencies from scale, Shane Kenny of Irish biopolymer producer Bioplastech doesn't think biopolymers can compete on price with conventional plastics unless governments step in and regulate. "Without the regulatory push, the cost will always be the major driver," he suggests.

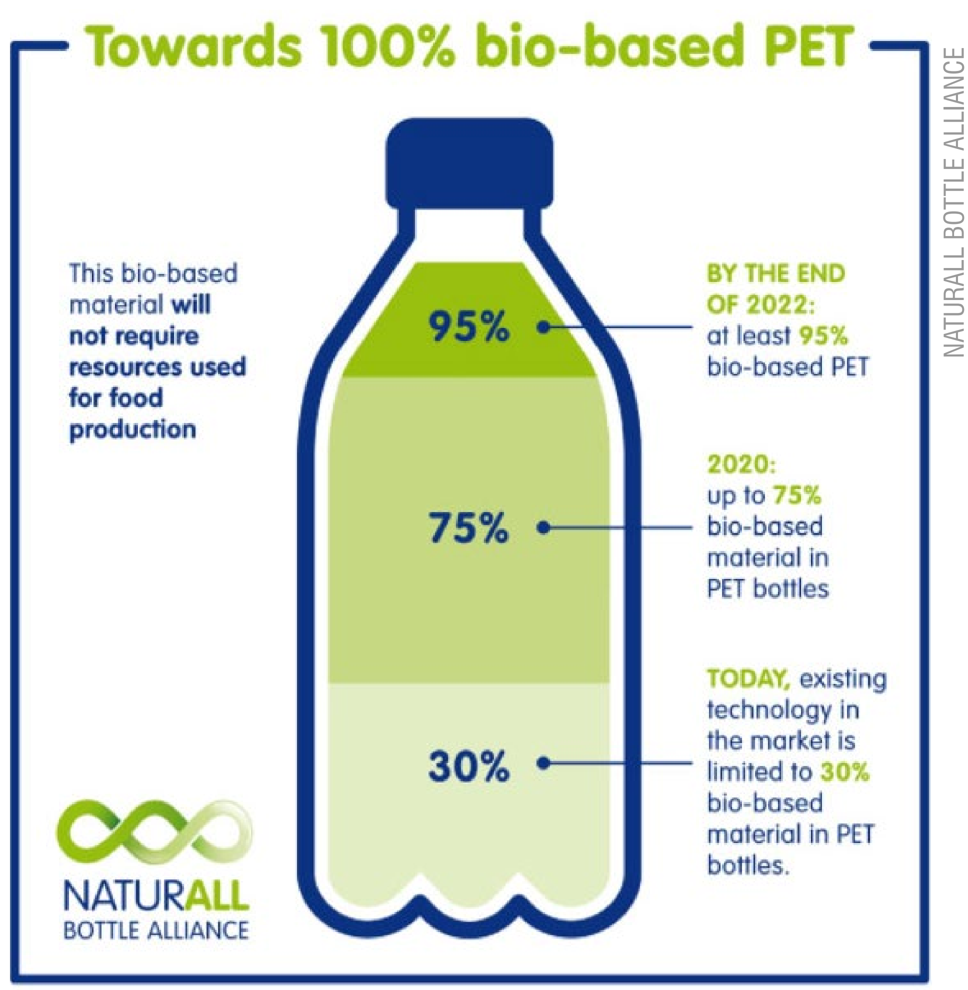
'Traditional polymer makers are very resistant to taking in new polymers, even if they have very repeatable and defined characteristics"

AirCarbon

What if you could use plastics to store harmful greenhouse gas emissions, such as methane? That's what California-based Newlight Technologies is working on, and it claims its AirCarbon product is able to out-compete conventional plastics on price. Initially its plants are designed to run on biogas from landfill, but Newlight eventually wants to use CO_2 as a raw material. Newlight's biocatalyst takes the carbon, hydrogen and oxygen from air and landfill gas and rearranges it to form the long hydrocarbon chains of a plastic called PHA (polyhydroxyalkanoate).

The company has a string of technology agreements, but two are particularly eye-catching: IKEA Group and the The Body Shop. Last year, IKEA said it would buy Newlight's AirCarbon, and ultimately produce the thermoplastic under licence for its range of plastic household furnishing products. The Body shop has been testing AirCarbon, latterly through the laboratories of its former owner L'Oréal. Ethical Corporation understands the challenge is to ensure the plastic can form an impermeable barrier, which is crucial for cosmetics products. The Body Shop's research is part of a commitment in its Enrich Not Exploit strategy to make sure that by 2020 70% of its product packaging is not derived from fossil fuels.

Minnesota-based NatureWorks is trying to commercialise its process to convert methane into lactic acid, which is the building block for a polylactic acid (PLA) polymer, Ingeo. At the moment, Ingeo is made from agricultural feedstocks.



Danone and Nestlé Waters are working together on green PET

Bioplastech

Another way to make PHA is to harness bacteria. Bioplastech, a spin-out from University College Dublin, is converting PET waste into a new polymer by recruiting the services of micro-organisms. The Irish company is pyrolising PET waste at 450C. This process delivers one of the building blocks of PET, terephthalic acid, in solid form, alongside liquid and gas fractions (the gas being used for energy recovery). Since PET can't be continuously recycled, conversion to PHA could be an attractive end-of-life scenario: it is totally biodegradable.

One particular strain of bacteria discovered in contaminated soil at a PET waste processing plant has proved very effective at using terephthalic acid to produce PHA. "It's a bit like humans accumulating fat as an energy store," explains Shane Kenny, director of bio-processing. He claims Bioplastech's PHA is more flexible than other PHA on the market.

Bioplastech is part of an EU consortium, P4SB, which ultimately aims to build a pilot plant producing PHA. Ideally it would find alternatives to pyrolysis to break down the PET. Its partners at the University of Leipzig are exploring enzyme degradation of PET that would potentially deliver a purer feedstock. They're also experimenting with an enzymatic approach to degrading polyurethane, which currently has very low recycling rates.


IKEA GROUP

IKEA Group aims to make AirCarbon for its plastic furniture

Others in the consortium are working to engineer more productive strains of bacteria, while Bioplastech tries to improve the fermentation process, which affects both the quality and the amount of polymer that is produced. At the moment Bioplastech's process can convert about half the carbon in terephthalic acid to novel polymer.

They won't be able to achieve 100% conversion, because some of the carbon is used by the bacteria themselves. Since the bacteria are killed to extract the polymer, Kenny suggests they would provide valuable animal feedstock or, at worst, fertiliser.

Danone and Nestlé have a partnership with Origin Materials to develop 100% bio-based PET

The main hurdles the company faces involve driving down costs. Kenny also has to contend with the fact that "traditional polymer makers are very resistant to taking in new polymers, even if [they have] very repeatable and defined characteristics."

While the bulk of Bioplastech's work is on developing a cost-effective plastic, it's also looking at a range of other applications, from adhesives for packing tapes, to reusable labels.

A biodegradable label and adhesive would allow certain food packaging to be composted. This is important, because just 5% of a non-biodegradable product creates a big problem for industrial composters.

Bio-based PET

Earlier this year, French food group Danone and the bottled water division of Nestlé announced a partnership with California start-up Origin Materials to develop 100% bio-based PET (polyethylene terephthalate) bottles within five years.

Origin Materials began life with the aim of making biodegradable plastics, but has since developed a process to turn non-food (lignocellulosic) feedstocks like wood chips and sawdust into p-xylene, a key ingredient to make PET. Founder John Bissell has the backing of the two multinationals to build a plant that will make around 10,000 tonnes a year of p-xylene.

Origin has already made 80% bio-based bottles at its pilot plant, but the initial commercial goal is less: 60% bio-based by the end of 2018. That's down to being able to find a commercial biomass source of another key raw ingredient. So for now, some of the PET will be produced from petro-based feedstocks. However, the ultimate aim is to have at least 95% bio-based PET bottles within five years. Bissell expects carbon emissions from the Origin process to be "substantially lower" than producing it from fossil fuel sources. The PET bottles produced are functionally and visibly indistinguishable from those that are being made today and will be recyclable. While the R&D will focus initially on cardboard, sawdust and wood chips, other materials, such as rice hulls, straw and agricultural residue, could also be explored.

NEWLIGHT TECHNOLOGIES

California-based Newlight is making plastic from CO_2

Avantium

Dutch-based Avantium believes it can commercially produce a stronger bio-based plastic with better barrier properties than PET. This is bio-based polyethylene furanoate (PEF). It's made from first-generation sugars, but the expectation is that in the longer term Avantium will make the building blocks for PEF from lignocellulosic feedstocks, such as wood and agricultural residue. The polymer can be recycled with other PET waste, but the company anticipates recycling of PEF alone will become commercially viable.

Avantium says bio-based PEF has better barrier properties than PET and could deliver a longer shelf life for food

Chemical differences between the two polymers mean that PEF has better barrier properties for gases such as CO_2 and oxygen, which could deliver a longer shelf life for food. On top of that advantage, a higher mechanical strength means thinner packaging will be required. Avantium says making PEF cuts CO_2 emissions by up to 70%, compared with manufacturing PET.

To exploit the technology, Avantium and BASF have set up a joint venture company, Synvina, which intends to build a 50,000 tonne pilot plant to make the monomer for PEF. A consortium of 11 companies led by Synvina recently got EU funding to develop a value chain for materials and chemicals based on PEF. It includes companies such as Nestlé, Lego and Austrian plastics manufacturer Alpla.


AVANTIUM

Dutch-based Avantium is making PEF from sugarcane

With so many promising technologies coming down the pipeline, have we reached a tipping point? "There's been a weeding out of industrial technologies that were unrealistic - a lot of wishful thinking – it feels to me that most of the stuff that's being worked on is more complete," suggests Bissell. But until the first plant gets built, and works as it is supposed to, we won't know for sure. ■

Glossary

PHAs: polyhydroxyalkanoates. Naturally occurring family of polymers, which are usually made by micro-organisms. They are biodegradable, and can substitute for many other types of plastic.

PLA: polylactic acid. Biodegradable plastic made from corn starch and sugar cane, used to make plastic films and biodegradable medical devices.

PET: polyethylene terephthalate. Commonly used to make fibres for clothing, and in this context is known as polyester. Its other major use is for drinks bottles.

PEF: polyethylene furanoate. Has a similar chemical structure to PET, but made from plant based sugars. Can be recycled.

PE (polyethylene): the most commonly used plastic in the world. It is made from a hydrocarbon, ethylene, which is derived from natural gas or petroleum.

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