

Plastics in Packaging

Issue 239: September 2021

IN PERFECT HARMONY

How Samantha Thian is helping supply chains become sustainable despite a lack of standardisation

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Return of the pack

If participants at the recent Petcore Europe annual conference gleaned anything from the opening day of discussions, it was that the major bottleneck hampering efforts to reach the required recycling rates – not least in the EU – is collection. Logically, if you collect more and sort more, you can recycle more.

On top of the emergent reuse-and-refill revolution, various forms of deposit return scheme (DRS) have been popping up all over the place. From collection points for flexible packaging at supermarket doorways, to brands such as McDonald's introducing a scheme for plastics coffee cups, consumers are being increasingly asked to return their used packaging to ensure that it ends up recirculating, or 'closing the loop', as we say in the industry.

A DRS is no longer the prerogative of the elite few early-adopters, such as Germany and the Scandinavian nations. Across the EU, countries are queuing up to bring them to law.

Earlier this year, Reloop, which is an international non-profit organisation aimed at promoting a circular economy, tracked 20 years of growth in international drinks container wastage and how refillables and DRSs can reverse this trend. What was most noticeable in the beverage sales chart between 1999 and 2019, was that refillable glass had plummeted from around 70 billion containers to less than 50bn, while non-refillable (NR) PET had soared from just over 20bn containers in 1999 to more than 70bn in 2019. Refillable PET had remained fairly static during that period (more on this later).

To make this NR PET circular, more needs to be collected, and this is where DRSs have really changed the landscape in countries such as Norway, Iceland, Denmark, Germany, the Netherlands, Finland, Sweden, Estonia, Lithuania and Croatia. But more DRSs are coming: Malta launches its scheme this year, while 2022 sees the likes of Scotland, Ireland, the Netherlands (a reboot), Portugal, Slovakia, Latvia, Romania and Turkey come onboard.

Are you DRS-ready? The chances are that you'll need to be, especially if the plastics packaging industry is going to get its collection rates on track, reports Steven Pacitti

Greece and (probably) the rest of the UK follow suit in 2023.

Reloop chief executive and co-founder Clarissa Morawski explained to delegates that 2004 had been the start of a concerted push for DRS globally, with an uptick from 100 million people having access to such a scheme to more than 200m in 2005, and nearly 300m by 2021. Now, with continued pressure on the packaging industry, and the anticipated explosion of DRSs across the EU, she expects more than 500m people to have access to a scheme in the not-too-distant future. It sounds a lot, but with a global population approaching eight billion, there is clearly still a long way to go.

Addressing return rates in deposit jurisdictions, Reloop points to a 70 per cent average return rate in various US states that operate a deposit of less than \$0.07, while an 89 per cent return is found in countries including Sweden and Estonia, where the fee is \$0.10-0.15, and 94 per cent returns are witnessed in Germany, the Netherlands, Denmark and Norway, where the fee is upwards of \$0.15.

"We also compared return-to-retail systems, which are typical in Germany, the Netherlands, Quebec, and so on, and return-to-depot or hybrid systems, found in the majority of US states and Iceland. We found average return rates of 89 per cent in the former, and 76 per cent in the latter," explained Morawski.

While the credentials of a DRS are plain to see, let us return to the issue of refillable bottles. In terms of sales, 9bn refillable glass bottles are sold annually in northern Europe, 36.6bn in western Europe, and 5.1bn in southern Europe. The figures for refillable PET are very different, with 114m bottles sold in

northern Europe, 4.9bn in western Europe and just 6m in southern Europe.

We know refillable bottles are nothing new, but are we addicted to NR PET, or is it a case of needing to modernise the refillables? For Sebastian Lemp, corporate public affairs and circular economy specialist for Austrian packaging converter ALPLA Group, the latter is definitely true.

"Reusable PET bottles need to be more stable with a stronger neck finish, and they need to support washing treatments," he said. "ALPLA bottles withstand a minimum of 15 cycles. "Our reusable pool of bottles are 55g for 1-litre and 38g for 500ml, and we've successfully tested recycled PET."

He added that The Coca-Cola Company uses 500ml, 2l and 2.5l refillable bottles in Costa Rica, Mexico and South Africa and they have a minimum lifetime of 25 cycles.

"PET outperforms aluminium and glass across carbon footprint and water consumption, for a 500ml lemonade bottle, for example," said Lemp. "Refillable PET bottles also outperform refillable glass and aluminium."

Lemp admitted to a decline year-on-year in refillable PET bottles due to the switch to 'single-use', but points to EU Member States looking at reuse, which will inevitably lead to an increase.

"A combination of the two is likely, including an increase in all sorts of reuse models," he predicted. "Refillable PET bottles can just be recycled when they reach their end-of-life and there are too many scratches on the surface. In Germany, they basically have closed-loop recycling for reusable bottles.

"In France, they only have targets for refillable glass bottles, which is a problem because they won't look at PET. French non-profit Citeo is doing some standardisation work on refillable PET bottles. Those initiatives are important as we need to ensure that glass does not position itself as the only reusable solution."

At EU level, Reloop's Morawski stated that there is a significant push for action on reuse and refill. "There is ongoing European Commission (EC) work on reuse measures for packaging, such as mandatory reuse targets for primary, secondary and tertiary packaging, including grocery, hospitality and transit packaging," she said.

A fast-moving topic for emerging Member State regulation, reusable packaging is being driven by EU direction, non-governmental organisation (NGO) pressure, and local political and consumer interest. Examples of regulations include Portugal's plan to introduce



Do refillables need modernising to gain more traction?



Reloop chief executive Clarissa Morawski expects more than 500 million people to have access to a deposit return scheme within years

mandatory reusable beverage containers for restaurants, and Extended Producer Responsibility (EPR) consultation proposals for mandatory pack reuse requirements in the UK. Taking it further, Germany's Packaging Act of 2018 committed to a 70 per cent reuse target for all beverage containers by 2022.

"In modern deposit systems, collection infrastructure is the same for one-way and refillable containers, and Germany is a perfect example of that, with the same machine used for different bottles," said Morawski.

Reloop estimates that 3.23 million tonnes of PET will be available from European DRS programmes by 2029. This is a rise from 1.65m/t in 2017, 1.8m/t forecast for 2022, and 2.78m for 2025.

"We know that 90 per cent is a reasonable target for separately-collected PET bottles from 1-3l, as that is the percentage median break for countries currently collecting bottles," she said. "We added the upcoming countries with a DRS, staggered up to 2029. Lithuania took two years to get to 90 per cent, but that was very fast. France is probably on a trajectory to a DRS, too, by 2029."

The estimated 3.23m/t of PET entering the market "should be clean PET and food-ready if it has come from a DRS", she added.

Morawski is adamant that circular PET must be the future if industry wants legislators to consider the resin: "We know that PET bottles can be collected and recycled into high-value food-grade PET, and back into another bottle. A DRS can help with that."

Mounting the kerb, or hitting it?

One EU country driving kerbside collections to the max, and with ambitions to become a European recycling hub, is Belgium. Indeed, the country has set itself increasingly ambitious recycling targets, pointed out Dr Patrick Laevers, managing director of Fost Plus, which seeks to offer recycling solutions for all household packaging.

Focusing on plastics, Belgium's recycling targets go from 50 per cent in 2020 to 65 per cent by 2023, and 70 per cent by 2030, with a household packaging recycling target of 95 per cent by 2025. Compare that with the EU targets of 50 per cent for plastics by 2025, and 55 per cent by 2030, with a household packaging target of 70 per cent by 2030, and it's clear that Belgium has set itself a high bar.

The new blue bag is a catalyst for the circular economy, according to Laevers. PMD (plastics packaging, metal packaging, and drinks cartons)

collection was extended in 2019, while five new sorting centres are to be built this year and five new recycling plants to follow in 2022. Around 10m people (86 per cent of the total population) have access to the blue bag in Belgium.

"There has been an injection of 700 million (\$824m) in the local circular economy," said Laevers. "Two of the sorting centres are online already. They will sort polystyrene separately, and also PET trays, while PET bottles are sorted to three different quality levels: transparent, blue-transparent and coloured bottles."

This, said Laevers, will help Belgium to increase kerbside collection of household waste and the collection of plastics packaging from 160,000t to 250,000t on a yearly basis.

"A minimum 50 per cent bottle-to-bottle rPET availability is guaranteed for Belgium," he added.

One of the new recycling plants is a joint effort by waste management firm Suez Group and water bottler Sources Alma, with the 40,000t/yr bottle-to-bottle plant due on-stream at the end of 2022 at a cost of around 40m (\$47m). After mechanical sorting, washing, grinding, thermal and mechanical drying, and screening, the process will see the granulation of material into flakes or spangles, extrusion into pellets, and polycondensation of PET molecules to ensure food-grade quality. Sources Alma will reintroduce the rPET into the Belgian market through its own brands.

One of the many debates when considering a DRS is whether to launch one that is material-specific: PET-only for example, or all-inclusive. Reloop supports the latter, believing that it's the fairest system as it introduces the same rules for all materials.

"PET and cans can be collected in the same machine and separated easily," explained Morawski. "In larger-space situations, you could have an additional machine for glass, or even the same machine. You could have a back section too for refillable bottles to stack up, so all sorts of configurations are possible."

Germany, a pioneer of DRS in many respects, is expanding its own system to include milk packaging and eventually beverage cartons as well. "The technology is ▶

Global population with access to deposit return systems for single-use beverage containers (1970-2020)



Single-use beverage containers wasted per capita, by country, 2017



evolving to take a broader scope in a more compact and dense situation,” she added.

In response to a delegate’s question regarding the coexistence of DRS and EPR schemes, Morawski remained bullish: “In Germany, Ontario, Lithuania, and Estonia, where a deposit system was introduced after a Green Dot system was established, the fee per kilogram of the materials did not go up.”

Laevers of Fost Plus disagreed with this synopsis, stating: “If you have two systems side-by-side to do the same tonnage, you don’t need an economics degree to know the cost will go up.”

From economics degrees to deep learning, it is clear that increased collection and sorting requirements put more pressure on the technologies behind the scenes. So what is the future of sensing and automated ID, and how do we improve the sorting of challenging items such as opaque PET, and trays and tubs?

From the all-encompassing artificial intelligence (AI) come machine learning, which is the scientific study of algorithm and statistical models, and deep learning, which uses artificial neural networks inspired by information processing and distributed communication nodes in biological systems.

Head of Tomra Sorting France, Frédéric Durand, compares training a network to teaching a toddler. By showing an object several times and explaining what it is, the parent ‘trains’ the toddler. Likewise, Tomra’s deep learning-based sorting technology, called Gain, is designed to enhance the accuracy of complex sorting tasks at high throughput rates.

Available as an add-on option for the company’s Autosort machines, Gain technology is also helping sorting machines adapt to new waste streams, which will be increasingly important as we move towards a circular economy. Deep learning enables computers to imitate human learning. The first application of Gain technology was for sorting silicon cartridges, specifically to eject PE-silicon cartridges from a PE stream by using data from vision systems. Given the potential silicon contamination, separating those cartridges from the target PE material is necessary.

According to Tomra, the technology was trained for this task with thousands of images and achieves an overall ejection rate of 99 per cent of the unwanted cartridges using two systems in a sequence.

“Gain also allows detection of overlapping, touching, deformed or damaged objects,” explained Durand. “New technology can increase recovery at sorting plants to 95 per cent.”

Beyond these options, for Durand, digital watermarks are the future when it comes to overcoming today’s limits, and will enable food and non-food recycling applications.

“Promising trials [of Holy Grail 1.0] showed a 90 per cent hit rate was possible with a regular mechanical setup with, for example, a belt



Refillable PET containers have lost momentum in recent years but Graham Packaging upgraded its offering last year by adding a bubble texture to its RefPET Generation III bottles to increase their average number of reuse cycles from 17 to 25

speed at 3m/s running a mixed packaging stream,” he commented.

He added that the ambitions for Holy Grail 2.0 include the identification of potential test markets and sites: clean or dirty; materials recovery facilities or plastics recovery facilities, and so on. They also aim to establish a dedicated ring-fenced digital watermarks project team to build, install and support test machines for industrial trials. A further objective is the continuation of add-on module development, connected to standard near infrared, based on new specifications.

“Museums of the world save the past, recyclers – the future,” Durand commented drily.

But could watermark technology change the future of collection schemes and make kerbside preferable to DRSs? Luca Stramare, project manager at Italy’s National Consortium for the Collection and Recycling of Plastic packages (Corepla), said that his organisation is constantly monitoring the current situation. But he added that Corepla’s design guidelines could be altered if watermarks were adopted to scale.

Tubs and trays a target

Pots, tubs and trays have increasingly become a concern - and a target - for recyclers. Conference delegates pondered whether the weight of PET trays might increase in the future in order to make recycling easier, running counter to the push for low carbon input that would be associated with lighter weights.

“I see a bigger push for lower-weight trays, to be honest,” observed Paolo Glerean, head of sales and marketing at Italian recycler Aliplast, who was also representing the RecyClass

certification system for plastics packaging recyclability. “It is different maybe for modified atmosphere packaging, where you have PE or EVOH [ethylene-vinyl-alcohol], which can create recycling problems. If you increase the thickness of the PET to improve oxygen permeability, to avoid EVOH, the technology will likely have some additives to improve the properties of the PET. I see more than just the use of more material to block the oxygen.”

Stramare agreed and added that increasing weight would be an easy short-term option to block oxygen, but that it would be a trigger for industry to achieve the same result with recycling compatibility.

“Barrier solutions that are compatible with recycling will be sought long-term, of course, which also includes lighter weight,” he said.

Is it better to recycle multilayer trays mechanically rather than through chemical recycling? Not necessarily, according to Martin Stephan, deputy chief executive of French biochemistry firm Carbios: “I don’t know any process today able to recycle multilayer food trays. The mechanical bottle-to-bottle process is good, not too expensive, and does not require too much capital expenditure, despite limited feedstock choice. After six or seven cycles, you cannot then reprocess the material again. Mechanical recycling is great to extend a material’s life, but it’s not a solution for the end-of-life, it’s a reuse option.

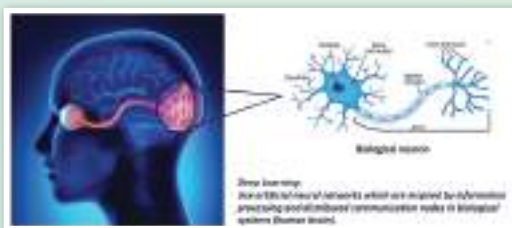
“With food trays, maybe we will find a technology to reuse them, but we will face the same limits as the bottle-to-bottle mechanical recycling process. My solution is monomer recycling.”

An overarching concern in the sector is where circular PET is headed, when it comes



Above: The first application of Tomra Sorting's Gain technology was for sorting silicon cartridges from a PE stream

Below: Tomra Sorting explained that deep learning enables computers to imitate human learning



to alternatives to mechanical recycling. As Stephen Short, president of Petcore Europe, explained: "PET producers want depolymerisation to monomers to happen. It's the future. We need to give them circular materials."

It's hard to see how mechanical recycling will enable the sector to reach its targets, so it is an unavoidable reality that chemical recycling will have a role to play, going forward. And this, of course, can take several forms.

Monomer recycling is the breaking down of a polymer to its monomer constituents and then reusing the monomers directly for repolymerisation. As Mike Neal, senior partner of Petkonsept Polymer Consulting, detailed: "This must be registered under the EU's REACH regulation as it's a manufacturing route to a monomer."

There is also feedstock recycling (pyrolysis), which is the thermal degradation of plastics waste at different temperatures (300-900 deg C) in the absence of oxygen, with the addition of a catalyst to produce liquid, gas and solid hydrocarbon products.

"Flake injection [FI] is also chemical recycling but it's not monomer recycling," Neal explained. "It's a hybrid process legislated by REACH regulations concerning plastics, mechanical recycling, and good manufacturing practices [GMP]. Mechanically-recovered post-consumer flake is fed directly into a PET manufacturing plant, where it is internally depolymerised, cleaned and repolymerised. The output is virgin-quality, recycled-content PET."

According to the European Food Safety Authority, FI is a chemical recycling process, but it is subject to the GMP regulation as it produces a food-contact material (a polymer).

"It is a polymer-in-polymer-out recycling process and is probably exempt from the REACH regulation," pointed out Neal. "The European Commission [EC] is going to produce legislation to include chemical recycling, but there will be some exemptions to that legislation. There will be better enforcement and a requirement to ensure that no genotoxins can be passed on to consumers."

Believing that plastics and polymers continue to have a vital role to play in the packaging industry, Nestlé Waters' packaging material and sustainability group leader, Jean-Francois Briois, explained that the company pledged CHF1.5 billion (€1.6bn) towards food-grade recycled plastics last year.

"PET is a polymer designed for recycling," he commented. "It is derived from a reversible polycondensation reaction. Unlike polyolefins, the output of PET monomer recycling can only be used for making PET, not energy."

For Briois, PET monomer recycling needs to be supported and the collection of non-mechanically recycled PET items must be structured and developed.

"Monomer recycling is more technologically-complex and is mostly developed by start-ups," added Briois. "Today, monomer recycling needs support at the R&D stage, in order to qualify as many feedstocks as possible, and to define relevant quality specifications."

He thinks that PET packaging can become truly circular by 2030, with monomer recycling one of the key elements in making that possible.

But a lot still needs to be clarified when it comes to where the various materials and technologies sit. For example, if there is a tax

coming on non-recycled plastics, is there a tax coming on virgin monomers and not on recycled monomers?

With a wry smile, Mike Neal responded: "The tax that the EC has created to pay for its problems, rather than sorting itself out, is based on non-recycled materials. However, as virgin [content] will be used to help prime the recycling circular process, I believe they support the recycling process rather than disapprove of it, so I'd assume a tax would not be appropriate."

Short pondered if recycled monomers could be claimed by brands as recycled content, and therefore get a reduction on the tax. It's all ifs and buts, or should that be smoke and mirrors?

Neal added: "We need to find the right measure for our industry, as we're different from the polyolefins, which need mass-balance as their materials are not being used directly back into polymers. I think for the PET industry, or polyester industry, we need a different kind of measurement system based on how it transfers its materials. The mass balance principle is used in a different context."

Ultimately, this all seems to come down to how resources are valued. What DRS systems and platforms such as ZeLoop – an eco-friendly app that rewards consumers for plastics disposal – attempt to do is to place value on undervalued materials.

As ZeLoop's founder Eric Schaffner pointed out: "Would you litter with gold? Plastics is simply not valued enough, and with ZeLoop, plastics is turned into gold. It is a smart method to educate consumers and leads to more collection."

What is clear from all of this is that PET remains firmly rooted in the strategy of brand owners.

"PET is the 'best for' solution, but it's equalled by being perceived as 'bad for' the planet," concluded Petcore's Short. "That's where we have to accept that we lost the war when marine litter hit the news. We have to forget that. The war is gone. We're now perceived as bad for the planet, so we have to come up with solutions."

"Gold has value, and we need that for PET, as it is 'best for'. Hurdles such as the EC and legislation are in front of us, but we can jump over them!"

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