

**PolyCE workshop**  
**How to get started with circular electronic product development –**  
**the secrets to design for and from recycling**  
**15.04.2021**



**Q&A**

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**KN1: How do we get from 30 Mt of plastic waste to 10 M t recycled content? Prof. Kim Ragaert, Ghent University**

*Q1: Could you please explain what you meant by "interplay between REACH and end-of-life/end of waste"?*

New products that are put on the market are subject to REACH and you have to list which substances are inside and thus prove that the product is safe. On the other hand, there is End-of-Waste, once the product is disposed and enters the waste stage – then REACH no longer applies, but the waste legislation. At one point, if you are a recycler, you have to cross over from waste and make again the transition to a new product, which is REACH. And at this point, there is disconnect, because plastics are so complex – there are so many different types of plastics, also additives. On a waste level, you can never completely identify what is in it exactly. There is no magical scan on plastics that identifies what is inside. There is legislative gap between transitioning from End-of-waste to start of REACH.

For more, please have a look at the following paper:

De Tandt et al. (2021): *A recycler's perspective on the implications of REACH and food contact material (FCM) regulations for the mechanical recycling of FCM plastics*, Waste Management, Volume 119, 1 January 2021, Pages 315-329

<https://www.sciencedirect.com/science/article/pii/S0956053X2030581X>

**KN2: Current challenges for the WEEE plastics recycling industry.**  
**Chris Slijkhuis, MGG Polymers**

*Q1: How do you test on big scale the presence of unwanted substances in waste feeds? It is not a simple or fast process. So how can you ensure that your analysis is representative of the whole feed?*

The answer is that there is not an absolute need to check each infeed on substances of concern. What needs to be verified is the REACH, RoHS and POP Regulation of the recycled products that re-enter the circular economy. Regarding the waste infeed, we know which fractions may contain substances of concern and the recycling industry has developed strategies to separate these plastics with substances of concern. A simple example: In the past we dealt with Cadmium containing pigments and these were typically yellow, orange or red. So by sorting out red, yellow and orange plastics the Cadmium load is reduced. We have

developed similar strategies to sort out plastics with substances of concern such as restricted Brominated Flame Retardants (see this [article and attached SOFIES Study](#)). If you have an academic interest to measure the waste infeed, which can be perfectly legitimate, EERA prepared a paper to explain how this can be done ([see document](#)).

Q2: *I don't understand the Notification meaning? What is it included in it: the recipe of the plastic? Is it the info present in the technical sheet product for example?*

The Basel Convention adopted a proposal from Norway to restrict the shipment of plastic wastes over international borders, to restrict marine litter. The EU adopted this restriction in the Waste Shipment regulation with a delegated act that was decided upon on the 22<sup>nd</sup> of December 2020 and implemented on January 1<sup>st</sup>, 2021. If you know that an average notification request for shipments across EU borders takes 3 months, but with large variations, you will understand that the impact for plastic wastes was larger than the 6 days delay caused by the Ever-Green container ship that wedged the Suez Canal. The issue is that plastic waste shipments have become de-facto unplannable and if recyclers like us – MGG Polymers – which deliver PCR plastics to high tech firms producing EEE products we need to offer a perfectly plannable production of our PCR plastics. We are therefore fighting to get a concept accepted that we call **Fast-Track Notifications**, for which we ask much simpler rules and procedures, much less costly administration, and much quicker treatment, if the recyclable materials go to so called pre-consented treatment facilities. This is a status that is granted by the competent authorities for Waste Shipments to treatment facilities that have proven and have been checked to be compliant with all waste legislations. For EERA I have worked on a few statistics and experiences, as we are trying to get an overview of the consequences of the implementation of the above-mentioned delegated act on the shipment of plastic wastes.

<b>Company Group</b>	<b>Number of notifications</b>		<b>Throughput time average</b>		<b>Total Volume</b>
	<b>Import</b>	<b>Export</b>	<b>Import</b>	<b>Export</b>	
<i>MGG Group</i>	56	12	90 days	135 days	165 kMT

The number of notifications that are related to plastics are 35 of the 56 import notifications. The highest financial guarantee is close to 150 k€ and the highest costs for administration is close to 20 k€ for one single notification.

Yes, we have indeed seen a spike in new notifications since January 1<sup>st</sup> as we requested 5 notifications since that date. But it is not that bad for us, as most of our notifications were already in place before Jan 1<sup>st</sup>, 2021.

We have one notification (for plastics) that took us close to 5 years to get – so the throughput times of notifications can largely differ, which makes the sourcing so unplannable. This is one of the key problems with notifications. Virgin raw materials can travel freely over borders in the EU and our raw materials supplies are largely unplannable. All our facilities are pre-consented facilities and hence notifications should not take more than a week. In the Fast-Track trial we did the quickest notification of 19 working days (which is still one calendar month) – according to

the website of the EU notifications to pre-consented facilities need to be issued within 7 working days, but even in our first pilot project with all the goodwill of all parties this turned out to be impossible.

***The experiences:***

1. With one notification request the amount of paperwork to document the transporters alone was a file of 40 Mbyte
2. We have had several notification requests where the competent authorities asked us for the costs of the treatment process, the revenues from sales and the costs of disposing our not recycled material. I consider this none of their business and it does not give any insight on the environmentally sound treatment of the process.
3. Although we have an obligation to report all disposals and where we send this to electronically to our ministry of environment in Austria (with annual on-site controls of the mass balances), we get requests by competent authorities in other countries to list all addresses of the locations where we are sending our disposal materials to. I consider this none of their business. Competent authorities should only deal with the aspects of their areas of competence – i.e. the country in which they are based, why would you otherwise have competent authorities in each country?
4. In many cases we are now confronted with the need to apply notifications electronically locally and that these notification documents are sent by post to many other countries – double admin work.
5. The calculation of financial guarantees differs per country and sometimes even per region (Germany in particular) and the handling is not transparent at all.
6. The same counts for the admin costs.
7. Of the 5 notification requests for plastics that we did since January 1<sup>st</sup>, only two made were granted within the 3 months until now. These material flows were green listed before January 1<sup>st</sup>, as these suppliers already separated the BFR containing plastics. All material with the risk of containing BFRs more than 2000 ppm of Br, already had to be notified according to the Austrian interpretation of the Waste Shipment Regulation. In many countries also plastics with BFRs could travel as green listed waste before and you can imagine what a problem that means for these companies not having any experience at all with notifications.

*Q3: How can you manage the traceability of each feedstock and guarantee the same RA, such as heavy metals?*

We do not measure our feed-stock, as this is not re-entering the circular economy. As WEEE plastics recycling industry we need to comply with REACH, RoHS and POP Regulation and we screen and analyse the PCR plastics that we produce to these legal requirements.

*Q4: Why using carbon black color masterbatch if heating and increasing temperature are an issue with the EEE?*

The application of Carbon Black is the standard for making PCR plastics black.

*Q5: What kind of optical sorter is used to separate the different polymer if there are a lot of black flakes ?*

We do not separate black flakes by means of optical sorting.

# KN3: Challenges with PCR plastics – Examples from a large household appliances manufacturer. Roberta Bernasconi, Whirlpool

Q1: What type of analysis do you make in your lab, please more details and the frequency?

The details of the tests performed in our labs and its frequency is a confidential information. I can share the tests done as part of the PolyCE project (in the table here below):

**Table - Physical Properties - PP Homopolymer 40% CaCO<sub>3</sub>, medium flow**

Property	Test Standard	Test Condition	Unit	Value
Rheological properties				
Melt-flow rate	ISO 1133 or ASTM D1238	2.16 kg @230°C	g/10min	8.0-16.0
Mechanical Properties 23°C at 50% relative humidity				
Tensile stress at yield	ISO 527-7 ASTM D638	50 mm/min	MPa	22.0 min
Flexural modulus	ISO 178 ASTM D790	1 mm/min	MPa	2100 min
IZOD notched impact strength	ASTM D256A	23°C	J/m	30 min

Charpy notched impact strength	ISO 179-1eA	23°C	KJ/m2	2.1 min
Thermal properties				
Heat Deflection (un-annealed)	ISO 75-2B ASTM D648	0.46MPa, 120°C/h	°C	88.0 min
RTI Temperature	UL 746B	1.5 mm, impact value	°C	65 min
Other Properties				
Density	ISO 1183 ASTM D792	23°C	g/cm3	1.20-1.35
Filler Content	ISO 3541-4 ASTM D5630	23°C	%	36-44

*Q2: Thanks for your presentation. Could you please give more information about your reliability tests?*

This is a confidential information, which cannot be shared.

*Q3: Do you think that service economy (sell a number of washing cycles instead of selling washing machine) will be more common in the future so you can recycle your own material?*

I personally think that selling the service (where the producer remains the owner of the product) could help the product reuse but not the individual recycling of material.

*Q4: Are you planning to change to recycled plastics in running production?*

Ideally, where it is possible the running change is preferred. But it might not always be the case. There are cases where you need to change something in order to be able to use recycled plastics.

*Q5: What is the price Impact (positive / negative) of this Approach?*

We do expect PCR to be cost competitive with virgin plastics.

*Q6: For the lab test, do you do the NIAS screening tests?*

No.

*Q7: How do you see the chances to change from "white goods" to "grey (or some other color due to recycling) goods" in the heads of marketing people and consumers? Does a washing machine have to be white?*

Our first target was to select non-visible application, where the color is not relevant. Washing machines doesn't have to be white, actually the part we selected it is not white and it is not visible.

*Q8: How do you make the rows tests, the frequency vs batches?*

I cannot comment on our internal practices, but only on what we made during the PolyCE project. We tested batches from one pilot collection

*Q9: Is the non-food grade issue purely legislative (it's not allowed) or also technical (it contains too much contamination)? In the latter case, what exactly are the problems or contaminations to overcome?*

Food-Grade is a normative requirement.

*Q10: Is it your PCR is recyclable, I mean is it detectable by IR in recycling line?*

The question is not clear, PCR is recyclable (it stands for post-consumer resin) and it has been recycled.

Jelle Saint-Germain - Ad Rem: To Manon & Mohamed: optical sorting (NIR) is not the only way to separate plastics. In a proper separation plant the plastic mix (also) goes through flotation units, which is a density-based and colour-independent technology.

*Q11: In the case of washing machine tubes with r-PP filled with CaCO<sub>3</sub>, were able to use them in the same application again? Can we say that closed-loop application was achieved? Is it already on industrial scale? If not, are you planning to scale it up soon?*

Yes, it was a closed-loop recycling (from washing machine to washing machine) and it was done on a pilot scale. The scalability is still unclear (possibly this question should be asked to MGG Polymers who owns the recycling process)

*Q12: A general question to all: Regarding the Basel Convention/ WEEE / R-plastics - A lot of the products sold for many orgs I work with have a large market in the US (that weren't signed to it I think and have very low e-waste rates). Are there any updates, regulations, similar strategies there (both design for use and recycling)?*

US is still behind on the management of end of life products (appliances specifically) but we have signal it might come in the future with the new administration.

## **P1: Introduction of the "two worlds": The world of recycling and the world of electronic product design. Thijs Feenstra, Pezy Group**

*Q1: What are your views on part material traceability in WEEE, consistent material making of material type and filler % varies across industries? Does the recycling industry actively check the marking on parts entering the sorting process in recycling stream? What is your preferred approach in terms of part marking for recycling?*

Thijs: Part material traceability: Just like virgin plastics, recycled plastics have to follow RoHS and REACH as well to be applied in products that are entering the market. The recycling industry has to comply with that.

Consistency is important within a certain range to prevent applications to fail during production or usage. Checking consistency is one of the activities within the drop-in method steps to release a product made from recycled plastics.

The marking has no function for products that are shredded. To my knowledge, they do not have a function during the steps of recycling.

Günther Höggerl, MGG: We do not check the marking on parts, partly as this is not always a reliable source of information. Example: some markets require BFRs in the plastics and in some markets not. The mould is used for both markets, i.e. the marking cannot be correct in all cases. Furthermore we are working on shredded plastics, so that marking information is lost already at that stage of the recycling process.

## **P2: Design for recycling challenges for product designers. Günther Höggerl, MGG Polymers**

*Q1: If we are designing to use recycled plastics, should we be looking at rPET, which is abundant in terms of recycled material source, but not widely found in current WEEE streams?*

We are arguing that the number of plastics in EEE products need to reduce, so why adding yet another type of polymer.

*Q2: 80.000 TPY of WEEE plastics recycled seems to be very low. Where is this number coming from?*

This number is from Plastics Europe: 2020 Plastics - the Facts

*Q3: You have also TPE, a big range of density: 0.88 to 1.3*

Correct - yet another challenge.

*Q4: Which are the highest value polymers for recycling in WEEE streams? Which is usually sorted out first?*

Separation is about harvesting the lower hanging fruits first, i.e. those polymers represented most in the mixed WEEE plastics fraction. In Small Domestic Appliances these are ABS and PS.

*Q5: And are there any confusion between ABS and other polymers?*

Probably this is related to the question about TPE above and the answer is yes.

*Q6: What would be the trade off in colour? Could an Off-Black be sorted?*

Even Off-Black would be difficult to be sorted with NIR, and to give a practical answer, Dark-grey might be possible, black not.

*Q7: For those parts already marked with triangle 7 and >ABS<. Do we still shred them?*

Most E-Waste in the EU is treated in such a way that the WEEE plastics recycling step is the last one in the recycling process - i.e. practically all plastics are already shredded before they enter the plastics sorting.

*Q8: What is really necessary in term of fillers? Do you think that the product specifications should be standardized with a max LDR?*

The designer defines the necessity of fillers not the recyclers. What do you mean by LDR?

Thank you that was really interesting!

*You are welcome, thank you.*

*Q9: Also a lot of recycled Plastics are sold in black as this an achievable colour from recycling. This seems to be a drawback to close the loop.*

We offer tech PCR polymers in black and a number of lighter shades of grey.

*Q10: What about 2k Solutions ex. PP + TPE (TPV or SEBS)?*

*If it is PP with TPE we are fine with that, ABS with TPE as example would be more difficult, as they are not compatible.*

*Q11: Does company such as Impact recycling could be considered to remove the colour for example?*

This is a technology that we do not use, we have no knowledge about this.

Jelle Saint-Germain - Ad Rem: **To Manon:** at Galloo plastics we use flotation processes to separate the plastics. All black plastics are being recycled same as the rest. We also export this (patented) technology to other companies such as AO Recycling (UK), ARN (NL), and Planic (Japan). Using this technology, black plastics are not a problem to recycle. Different flotation processes on salt have existed for decades as well.

*We are aware of this, thanks.*

### **P3: Why designers and OEMs should know the EOL of their products. Nazarena Vincenti, ERION**

*Q1: Could you please give us more information about your lab test and the frequency (by batch, by month or by year...), how you make process follow?*

As mentioned during the presentation, Erion was involved in the demonstrator activities foreseen in the project. In detail, Erion managed the collection and treatment of WEEE according to the clusters defined (1. Drawers – C&F, 2. Washing machines and washing machines drums, 3. Printers, vacuum cleaners and coffee machines). Following the treatment step, several samples of mixed plastic flakes were collected (5 kg each) to characterize the plastic flow. In detail the following tests were performed:

- size distribution of WEEE plastic flakes;
- color distribution of WEEE plastic flakes;
- sample composition (polymers, metals, glass, rubber, etc.);
- regulation (EC) n. 1907/2006 (REACH), annex XVII;
- RoHS-Directive (2011/65/EU).

After the characterization of the plastic flow, recycling activities were performed by MGG and on the materials obtained (granulates) were performed a number of analysis to verify the fulfilment of product requirements and legal compliance requirement in accordance with the requests of OEMs (e.g. Whirlpool).

The measurements were carried out for each batch organized.

*Q2: Why were the glossy products crossed out in the diagram presenting the clusters? (Slide before Implementation - large household appliances). I am asking to understand if they present any challenge in recycling.*

During the discussion phase on clustering activities with other project partners, glossy products were identified as a potential interesting flow to obtain high-quality plastics considering that glossy plastics contained in products are of good quality. After the theoretical discussion, several sampling campaign activities were organized to characterize the flow “Small Household Appliances” applying a mathematical model to define the products to be clustered. It’s was decided to keep out the glossy products for the following reasons:

- identification of glossy products is a complex activity. It’s should be clearly defined what is considered “glossy” and what is not than it should be explained to operators that are in charge of the identification and separation of the products;
- usually products may contain a mix of glossy and not glossy plastics. This means that it’s not possible to obtain a bid bag of mixed glossy plastics. Sorting of plastics not glossy should be performed.

*Q3: If there is more reuse or repair, how it will impact your work? Will you be part of this loop?*

If there will be more reuse or repair (intended as private activities of repair and direct exchange between consumers), our work will be impacted with a dilution of the waste collected at municipal collection points for WEEE or at retailers sites: something that would have become a waste in 2021, will become a waste in 2025.

If reuse is intended as “preparation for reuse” then our work will be impacted significantly. Possibility for WEEE collected at municipal sites to take two routes: one through the mechanical treatment, another through the preparation for reuse facility. Erion could facilitate the recovery of valuable components to be send back for remanufacturing to the OEM for using them in new appliances. We could also being the key actor for managing the exchange of information between the consumers, the collectors, the recyclers and the producers. Erion could provide information to WEEE recyclers on appliances and components to be reused and could provide dismantlability feedback to EEE producers for a better design for reuse.

You can find more information on Erion innovative activities on the official website (<https://erion.it/en/research-and-inovation/>).

## **P4: Design from recycling and the Drop-in Approach. Thijs Feenstra, Pezy Group**

*Q1: Any challenges recycling "recycled" plastics?*

Since there is always virgin added, the mix is likely to maintain a very well usable quality level.

*Q2: On your drop-in complexity Level tool: Colours black are recommended. How does it fit with the recommendation to not use black Plastics for better sorting? Is this a dilemma and how to solve it?*

Detecting different types of black plastics is problematic when using only NIR as separation technique. There are other techniques that do not have these problems during separation. This is becoming state of the art technology.

Consumer products have a relatively long life time, comparing them for instance with the single use packaging industry. That means products that are now made from recycled plastics will be recycled probably a couple of years later. This gives even more time for the industry to implement the techniques that deal with black plastics. Therefore we do not foresee problems in the future.

## P5: Recycled plastics in new electronic product: The evolution of the Wireless Value. Joop Onnekink, Pezy Group

*Q1: I am a bit confused about PA. Is it a polymer widely recycled or it is better to avoid? I saw it indicated in red in the presentation from Joop, but I now see it indicated as advised plastic in the design for recycling guidelines?*

PA is a material which can be and will be recycled. However depending on the recycling category and the recycler who is recycling the plastic mix from this category the PA is seen as target material or as a minority which is not profitable enough to extract and clean. For the category SHA (Small Household appliances) research from KU Leuven during this project indicates that PA is only 1% of the total plastic composition. Therefore in this case the PA will not be recycled. (Plastics Recycling for Waste Electric and Electronic Equipment: Key insights and challenges, 2020)

So although in general PA is indicated by the recyclers as good, and therefore in the guidelines, depending on economics it will be part of the target group or not. For this product range we declared that PA was not part of the target group and therefore we tried to avoid PA, if possible.

## P6: Recycled plastics in an existing electronic product: The Philips SENSEO case. Gianni Vyncke, Ghent Universtiy

*Q1: Did you see any ways to have done it BETTER. How about the re-recyclebility? Is Black color blocking sorting for the next loop?*

First, on the question if we could have done better. I would say that you can always do better. However, there are several factors that need to be taken into account. For example:

- Depollution of polymers for food contact plastics, is the technology ready?
- Sorting of minor fractions, is this worth the gain?

Next to this you need to ask if better is needed at this point of time. You could spend funds, time and manpower to improve with little steps. Let's say 5% increase of PCR content compared to the 75% now. Or is it better to commercialize your results, get market input and apply your

learning to other products. In this way you can have many products with a large share of recycled content instead of one product with a slightly higher share of PCR plastics. Take in mind that now only 2% of plastics used in EEE are recycled. More products using a lot of recycled content can improve this more than one single product.

Secondly, on re-recyclability and black colour sorting. This again is a great question and this was taken in mind by Philips when designing the Senseo Eco. This product uses as much as possibly target polymers ( PP, (HI)PS, PC, PC/ABS & ABS) . This means that a large share of the overall plastic parts will be recycled and ensures maximum recovery of the plastics. Black colour sorting for now is a challenge but not an impossible hurdle. Many EEE products use black colours (this plays on the desirability section of a good product). This happens for products made from virgin or recycled plastics. The reason many recycled plastics are black is because the input is mainly black plastics. There is no difference between virgin or recycled black plastics for sorting.

*Q2: Looking at the nascent stage of rPlastics, the question comes to my mind is about the viability of Drop-down approach - due to the inconsistent supply of quality material of particular grade? For instance, can DfR start from the basis of the availability of a high volume & quality of particular grade?*

Interesting question, and your concerns are understandable. However, I would like to nuance a little bit. Supply is usually very consistent and availability increases over time as sorting efficiency increases and more and more is collected for recycling within Europe. I must say this is untrue for the last year but this is due to the huge impact of the Covid crisis. This is nevertheless a very big point of attention when looking at DfR with a drop-in approach. You need to specify and verify if your supplier can meet your demands. Related to your second question, you can start designing starting from a grade with high availability and set properties. This is however, nearly impossible from a Drop-in perspective. This should only be attempted when designing a completely new product, which also has a lot of freedom in the type of product, design and needs few parts without any high requirements. This is possible but not easy when working towards a specific product. When a grade is available it would require testing & listing the properties, comparing with existing materials, finding similarities and then looking at what this grade is used for.