

The quest for circularity and its ramifications

Circular visions and harsh realities, PackagingWorx

March 8th, 2022, Dr. E.U. (Ulphard) Thoden van Velzen



Plastic packages

- Most protection
- Lightweight
- Enables convenience products
- Transparency
- At limited cost...



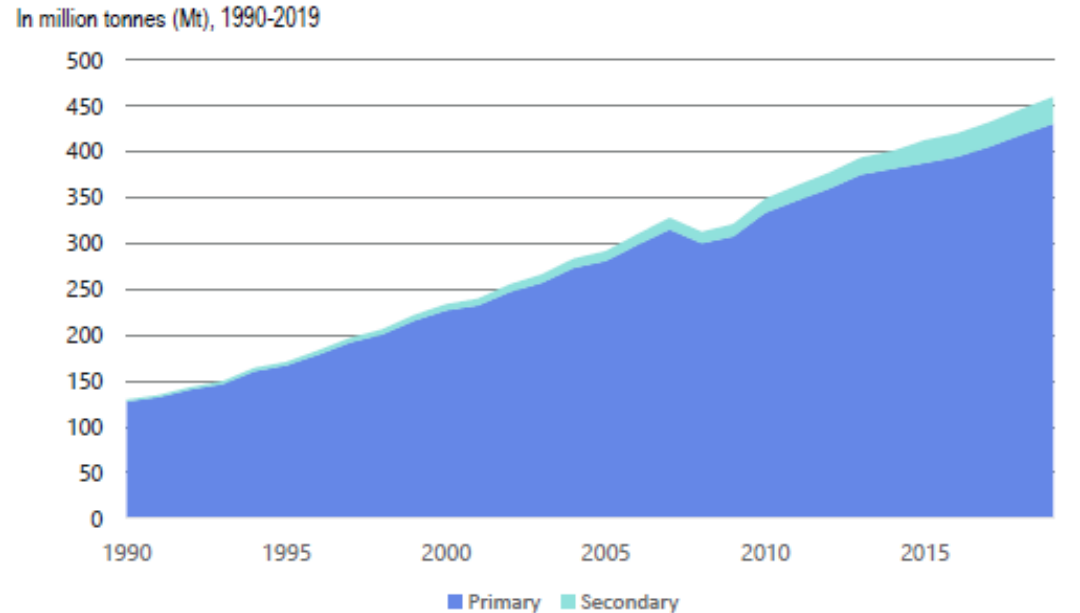
But plastic (packages) have downsides

- Greenhouse gas emissions
 - Advanced LCA tools
- Littering and plastic soup
 - Crude estimations



And the global production keeps on growing

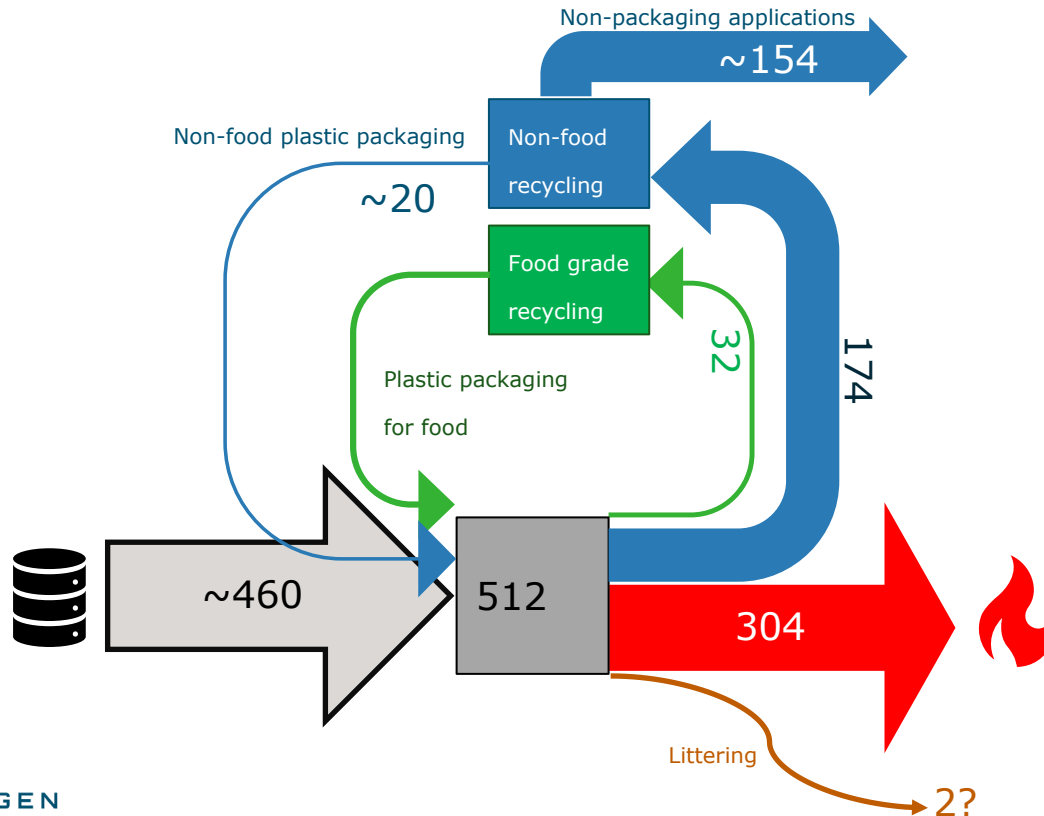
- Growth in Asia
- Stagnation in Europe
- Recycled plastics ~6%



OECD Global plastics outlook, 2022

Recycling of plastic packages in NL, 2017

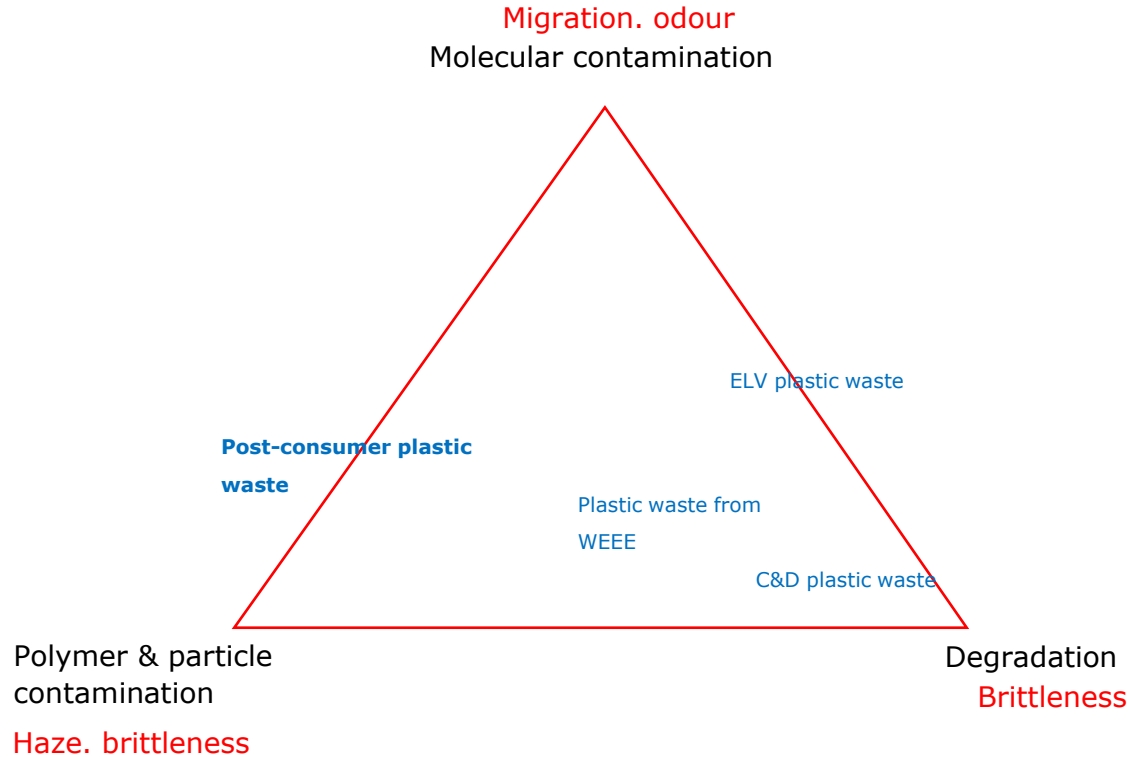
kiloton



Why is plastic recycling not fully circular?



2008: 3 main quality decay mechanisms



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Quality of recycled plastics

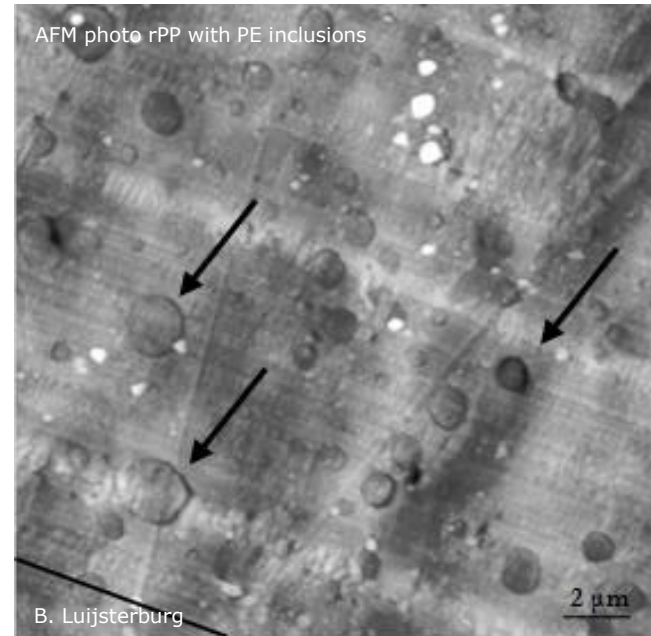
Sorted product	Recycling process	Molecular contamination	Polymeric contamination
PET bottles	Standard	Low after SSP	~0.1 – 1.0%
	Advanced	Low after SSP	<0.1%
PE DKR 329	Standard	Very high	5-10%
	Advanced	Very high	1-3%
PP	Standard	High	5-10%
	Advanced	High	1-3%
Film	Standard	Very high	8-15%
	Advanced	Very high	1-3%

Not suitable for food applications

Not suitable for packaging

Polymer contamination results in blends

- Most recycled plastics are blends !
- Most common particles are other polymers
- But also inorganic particles are found

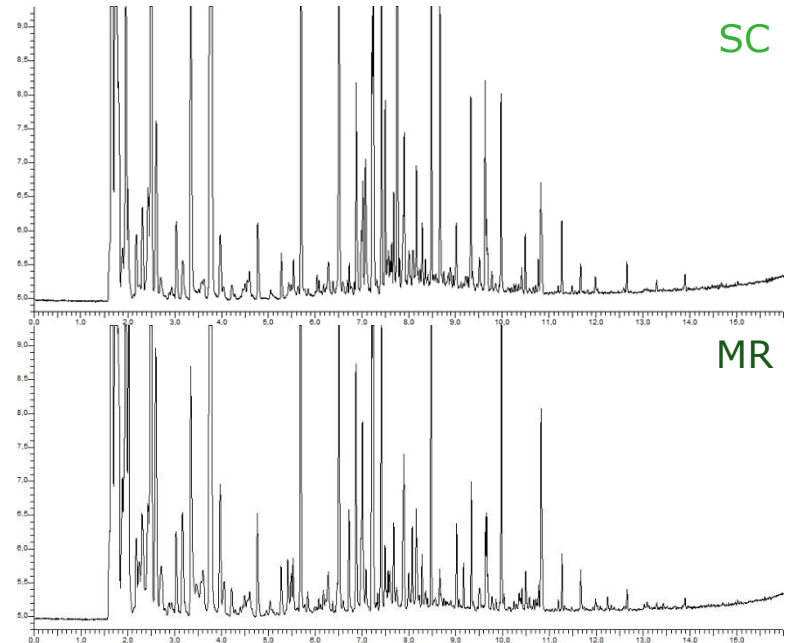


Particle & polymer contamination

- Inorganic inclusions -> SEM EDX (Al, Si, K, Ca...)
- Black spots -> SEM EDX / Micro-IR -> C (burnt paper?)
- PET -> partisol
 - Virgin ~ 10 million particles/gram
 - Recycled > 100 million particles/gram
- Results in Haze, holes, reduced impact strength, etc.

Molecular contamination

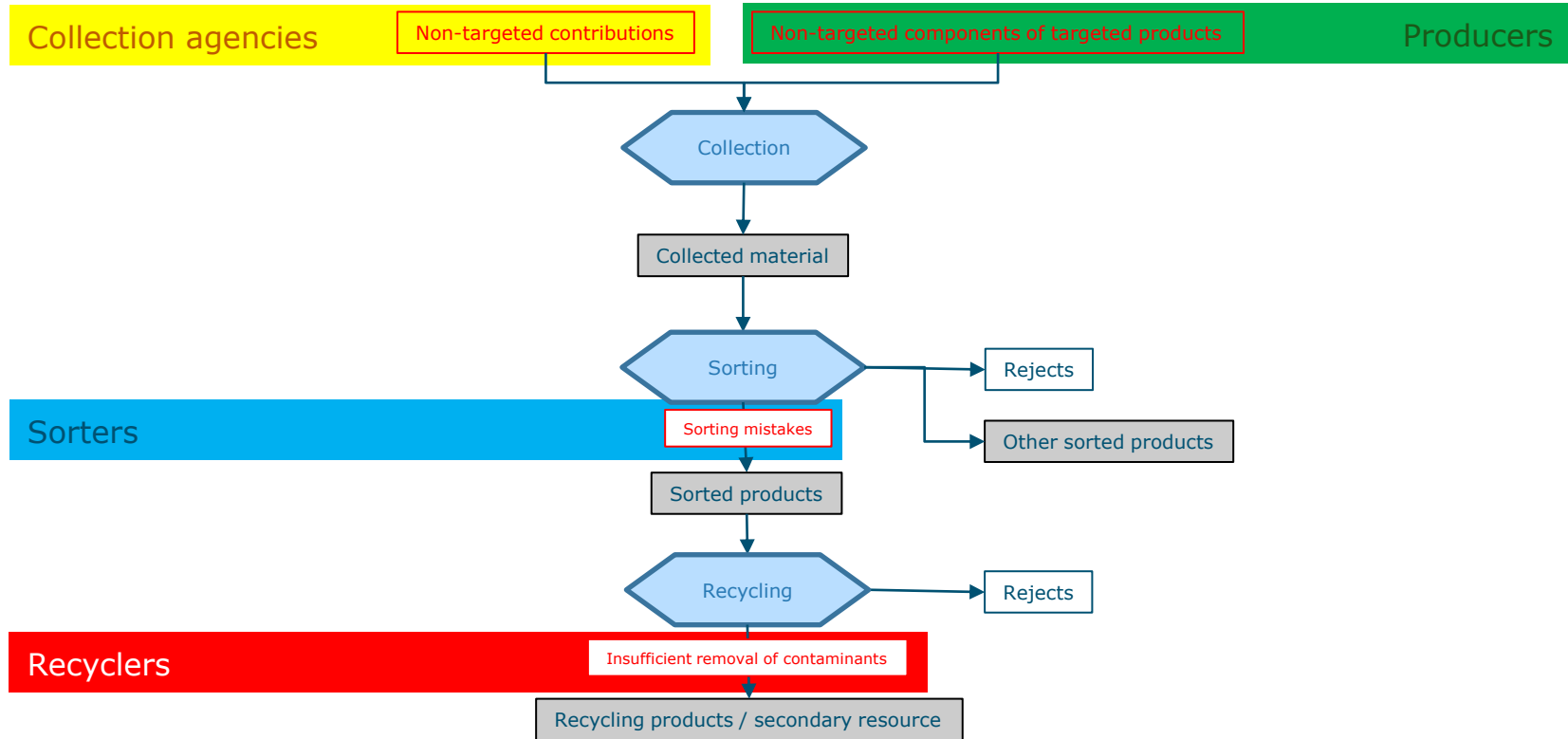
- Headspace GC of volatile compounds from recycled film made from **separately collected (SC)** plastic packaging waste and **mechanically recovered (MR)** plastic waste.



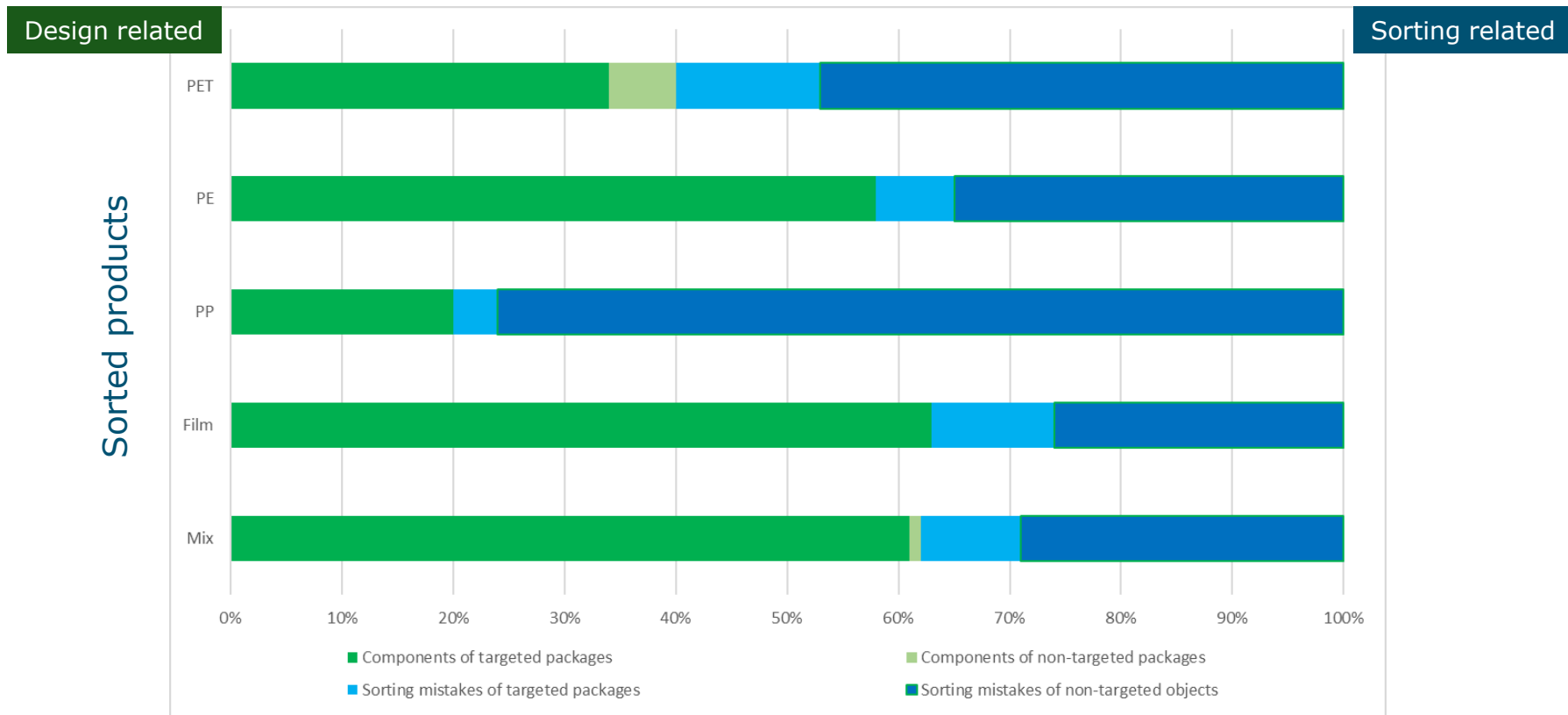
Molecular contamination – an overview

Type	Type of molecules (MC)	Relative concentration	Odour activity	Food safety relevance
Oligomers & degradation products	Homologous series of alkanes and alkenes	High	Hardly	Negligible
Additives	Anti-oxidants (Irgafos), anti-slip agents (calcium stearate, Erucamide)	Limited	Non to hardly	High amides for
Additives from prints and labels	Plasticiser (DEHP, etc.), BPA, MOSH, MOAH, photo-initiators, phenols	Moderate	Non to hardly	EDC's
Incidental contamination with product residues	Strongly varying, for example: + paint residues (pinenes) + food (oleic acid, limonene) + pain relief lotion (menthyl salicylate) + odorants (linalool, ionones)	High	Varying	Varying
Microbiological metabolites and degradation products	Strongly varying: + Geosmine, 2-methyl-isoborneol, etc. + Short chain fatty acids, butyric acid + methyl sulphides and amines	Very low	Very high	Most negligible but also natural toxins

Quality: Source of contaminants



Source of polymeric contaminants



Why is recycling not circular?

- Most packages are **not** designed for (circular) recycling
 - Polymeric contamination -> opaque, hazy, brittle
 - Molecular contamination -> odour, food safety
- Lack of efficient decontamination technologies
- Much too strict legislation
 - Based on a triple worst case risk assessment

Producers

Recyclers

Government

We need a concerted action



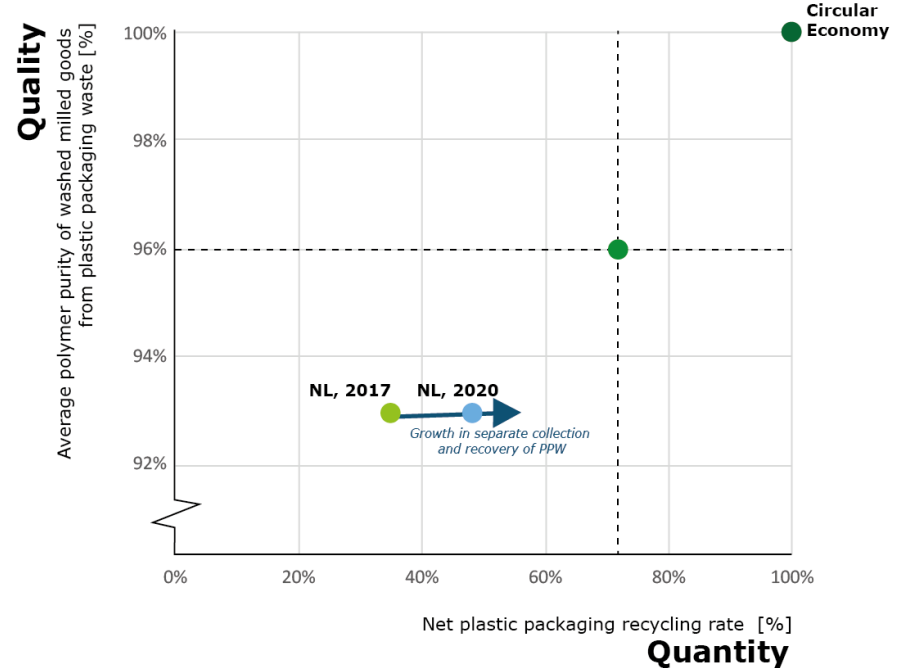
FMCG industries can start to act now

Recycling of PPW, progress in NL 2017-2020

Status 2020*:

- Recycling rate: ~48%
- Average polymer purity: ~93%

Higher separate collection rates and additional recovery of PPW resulted in a higher recycling rate.

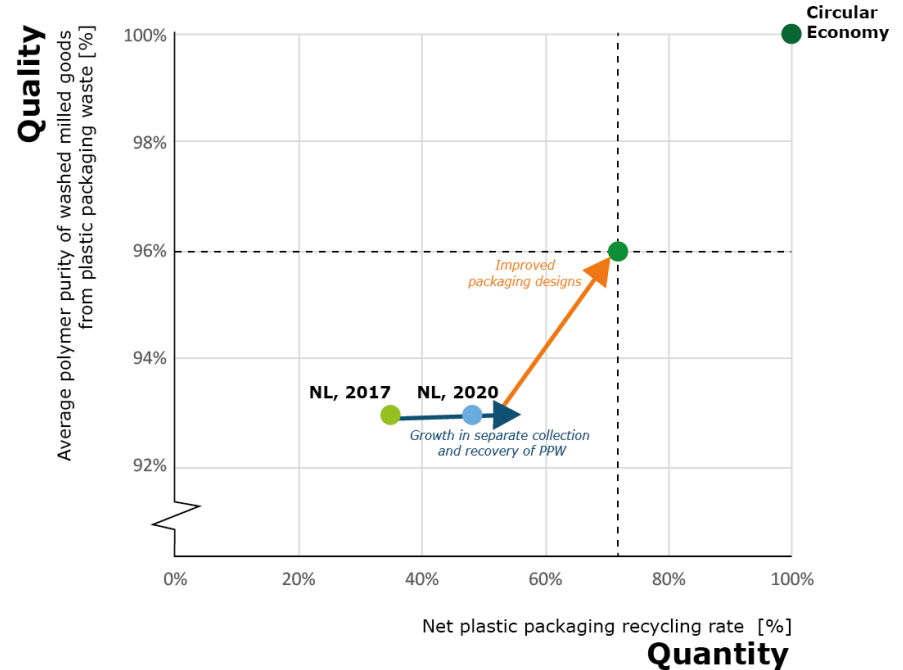


More circular recycling

- The recycled plastics resulting from this system are of **insufficient quality** for the application packages and consumer product

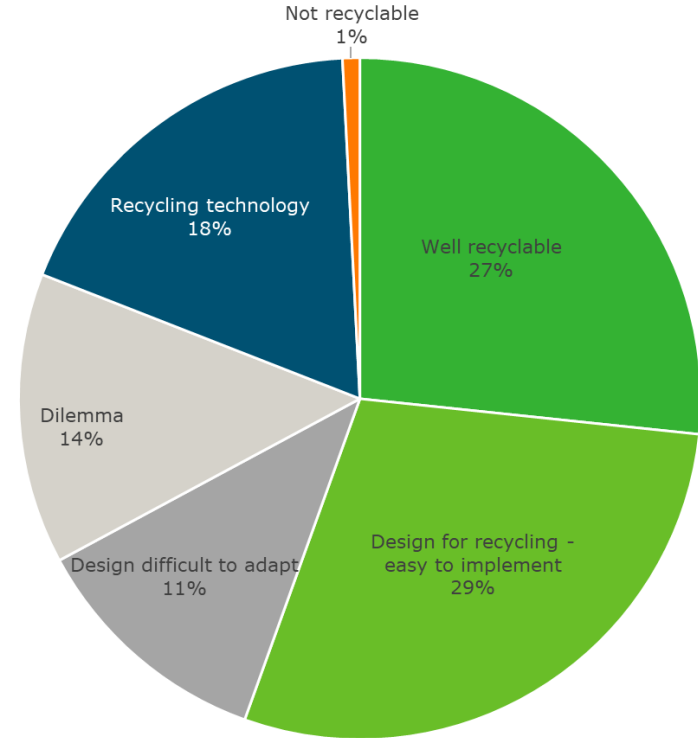
Design for recycling:

- improves the quality of the recycled plastics
- improves the chain efficiency



Design for recycling opportunities

- Status 2021: 27% well-recyclable
- Only 1% is not recyclable
- 72% improvement window
 - 29% easy to implement
 - 11% difficult to adapt
 - 14% dilemma's (food waste)
 - 18% recycling technology



Easy to implement (29%)



Packaging components that cause impurities (16%):

- Pump & spray mechanisms
- Unremovable (paper) labels
- Metal caps, silicone rings, etc.



Easy to implement (29%)



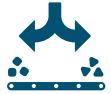
Big labels & sleeves (~3%)



Black packages (~7%)



Difficult to adapt (11%)



Small packages



Dilemma (14%)



Laminated films and rigids (~7.5%)

Beware of regrettable replacements



PP films (~6%)



Blisters for pills (~0.5%)

Challenge: medicine legislation



Recycling technology (18%)



PET trays (2021 started)

Solution: develop recycling technologies, redesign packages



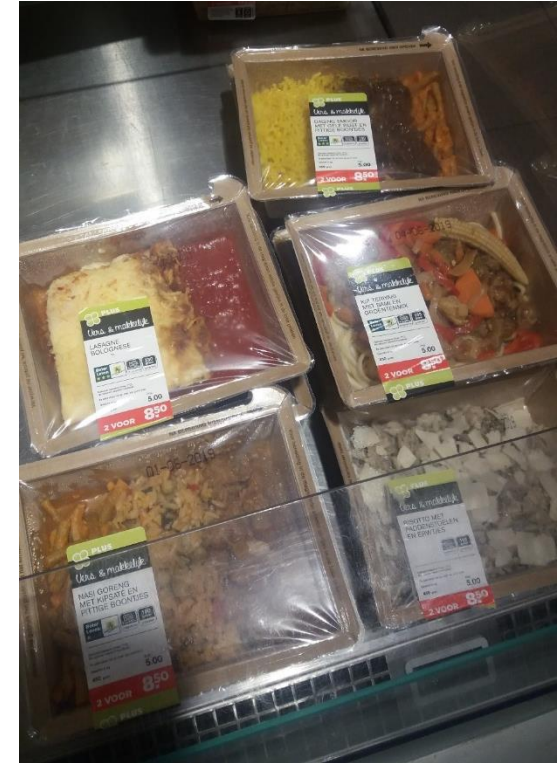
PS packages

Solution: replace by PE, PP or PET, or use as feedstock for pyrolysis

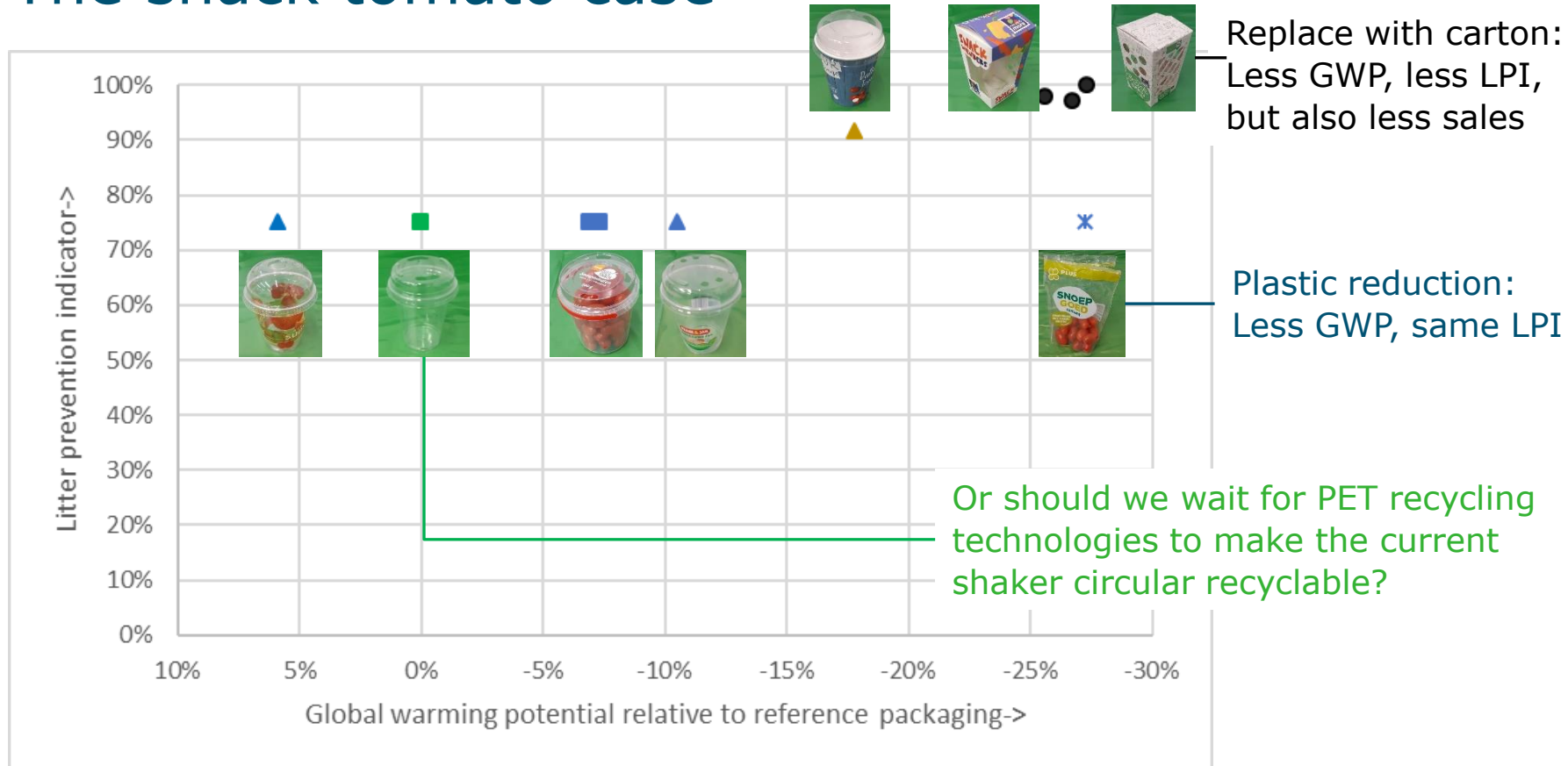


General challenges

- Dilemmas: disadvantages of alternative packaging like reduced shelf life, higher cost, less convenience, marketing factors, etc.
- International production chains; differences between countries.
- Confusion about what is recyclable.
- **Regrettable replacements:** “natural-looking” packaging that is not recyclable. For example paper / plastic combinations



The snack tomato case

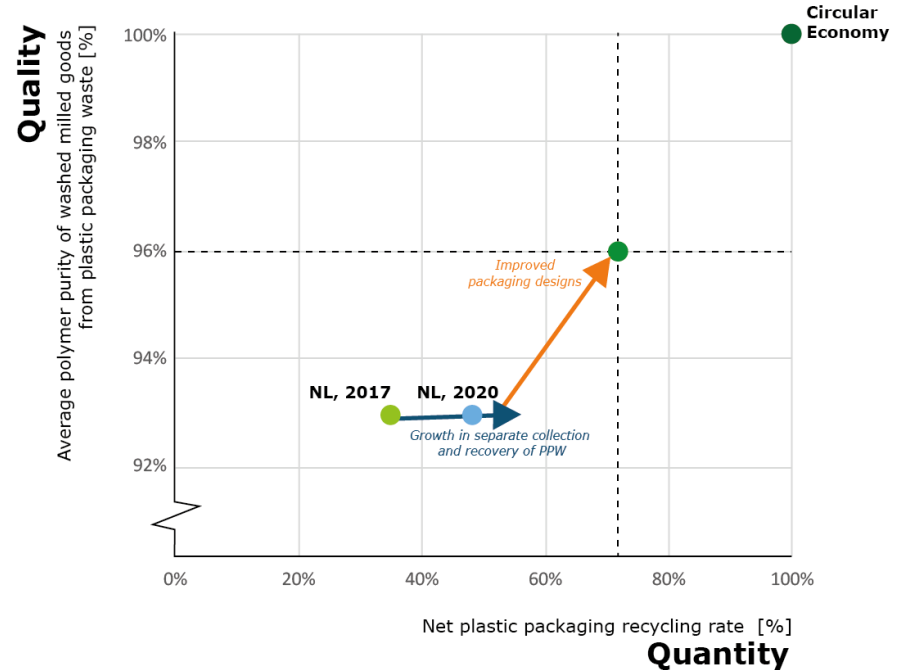


More circular recycling

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Design for recycling:

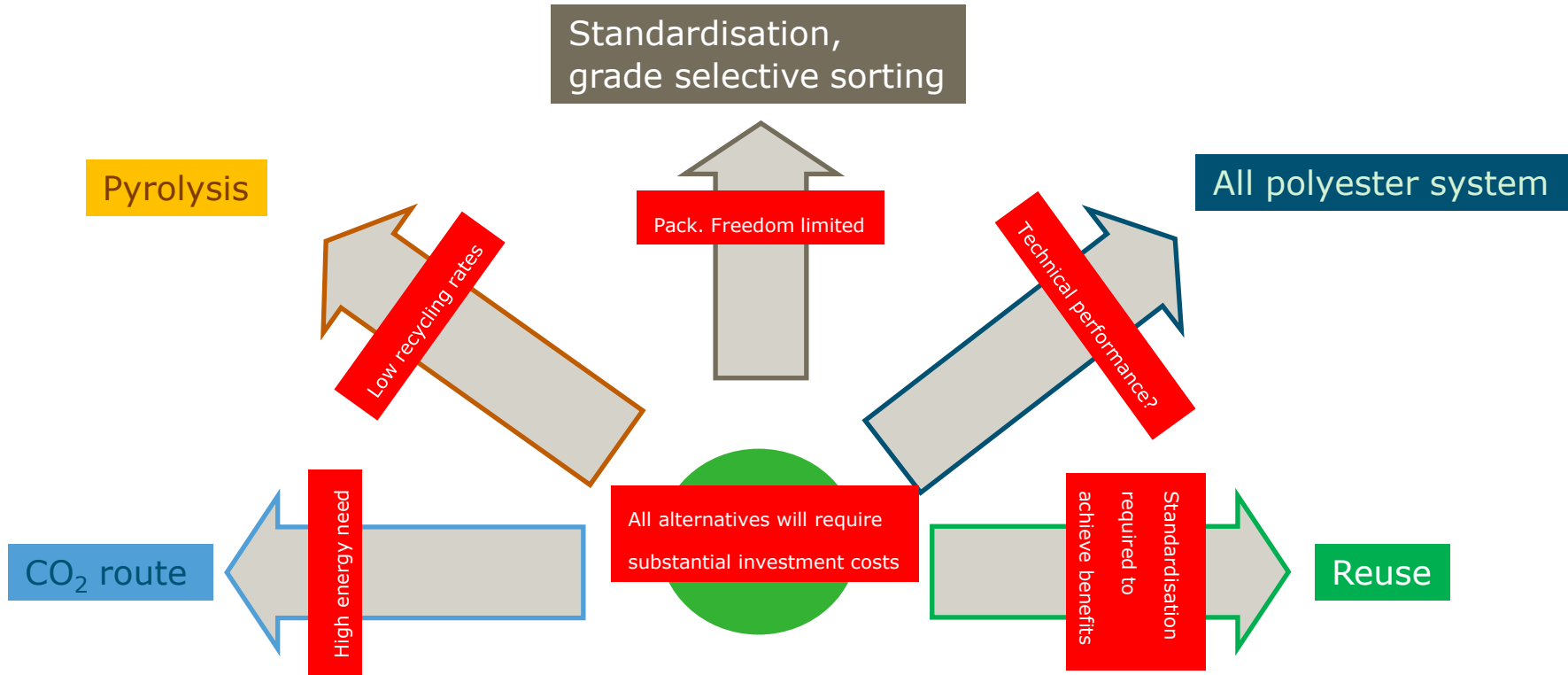
- improves the quality of the recycled plastics
- improves the chain efficiency



We need a concerted action of all stakeholders

- But... most stakeholders:
 - Do not feel the urgency to act, have other priorities
 - Do not understand the complexity
 - Believe in different solutions

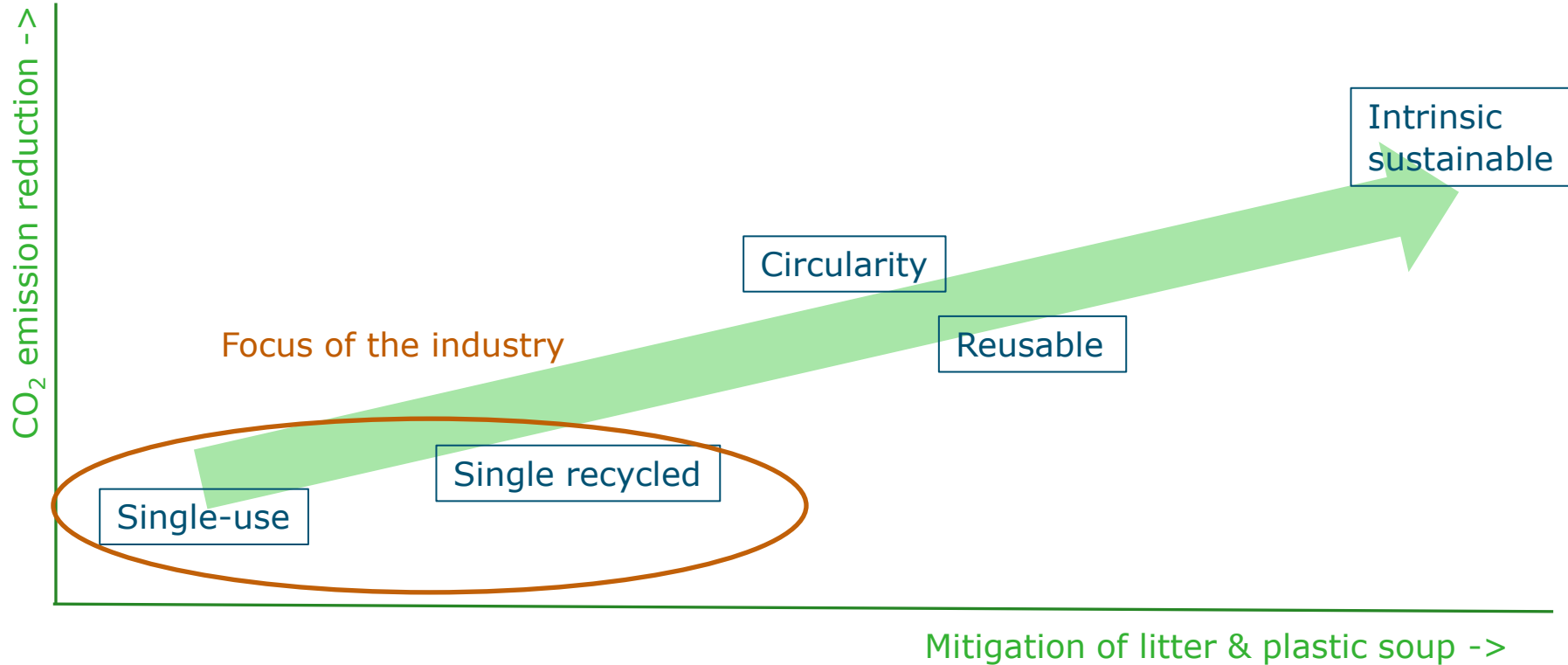
Multiple options, no quick fix



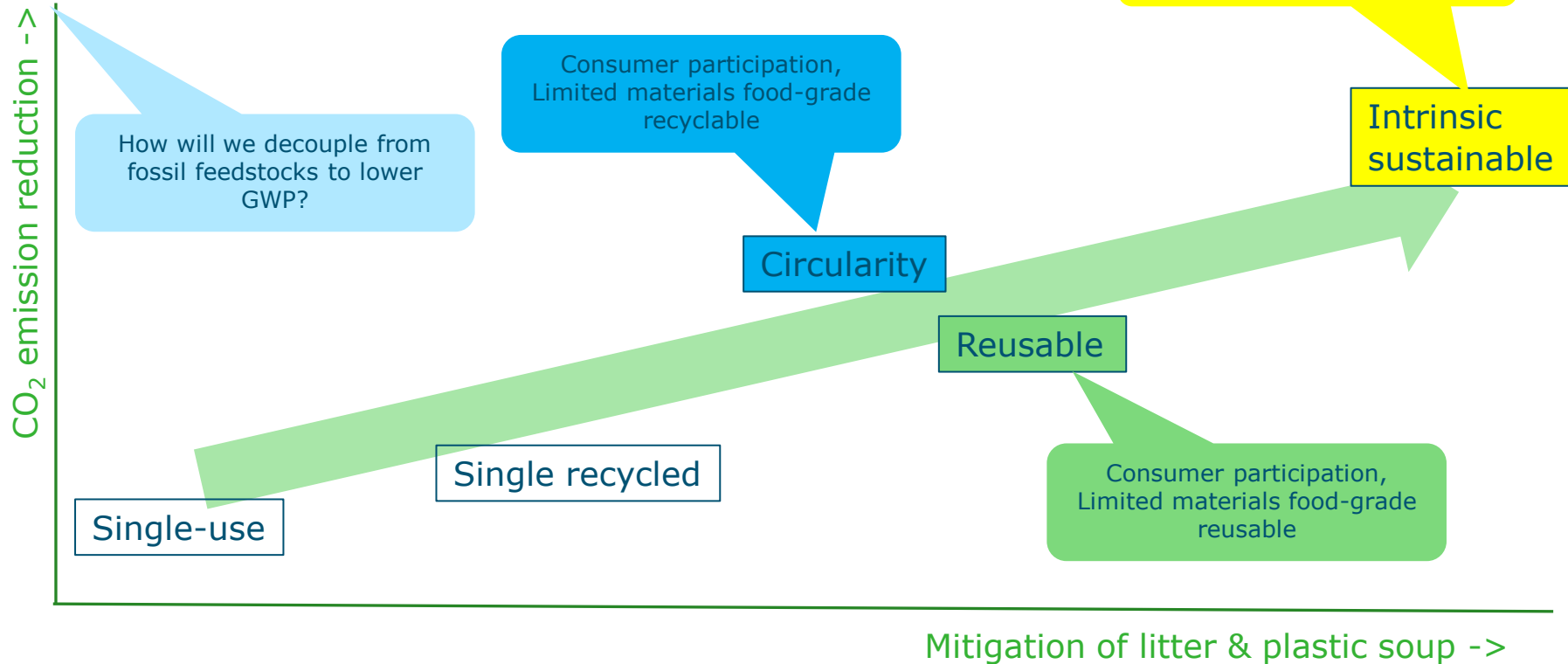
Governmental responses in the EU

- EU 1994/62 Packaging waste directive -> PPW RR 22.5%
- EU 2008/98 Waste framework directive
- EU 2008/282 Directive on FCM made from recycled plastics
- EU 2018 Plastic Strategy
- EU 2018/852 Revised packaging waste directive -> PPW RR 50%
- EU 2019/ SUP directive
- *New revisions, taxes, bans, RC content policy, reuse targets*

Scientific perspective on sustainable packaging



Dilemma's on route



Thank you for your interest

Small steps to increase the recyclability of plastic packages are meaningful.

Discover bespoke solutions.

Plastic waste deserves serious attention

