

'We've still got a way to go'

If we are to make optimal use of our household waste, we need to sort and retrieve the raw materials more efficiently. 'We are still a long way from the ideal, circular-economy picture.'

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The Netherlands is ahead of the game in Europe when it comes to the collection, sorting and recycling of household waste. Many countries still work with landfill but in the Netherlands all the residual household waste gets incinerated and only the ash gets dumped. At the same time, there has been a shift towards the sorting and separate collection of glass, paper, textiles and organic waste. Recently, the collection and recycling of plastic packaging has been added, often in combination with drink cartons and tins. Paper fibre in drink cartons is salvaged that can then be used to make perfectly good hamburger boxes. In spite of the head start the Netherlands has gained in Europe, we need to give serious thought to how we are going to collect and process waste in the coming years, says Ulphard Thoden van Velzen, who works at Wageningen Food & Biobased Research. He does research on the separate collection of plastic waste. Several analyses show that it is still only a small proportion of the packaging plastic that is recycled to make pure material for new packaging. 'We are still a long way from the ideal, circular-economy picture,' says Thoden van Velzen.

In spite of waste sorting, valuable materials such as paper, cardboard, plastic and organic matter still end up in the non-recyclable household waste. So Dutch waste-processing companies such as Omrin, Attero, HVC, AEB and AVR have recently been installing post-collection



GENERATING ENERGY OR RECYCLING

The dumping of household waste in landfill has gradually diminished in the Netherlands since the 1970s. The Netherlands now has 12 large waste incineration plants in which 7.6 million tons of household waste goes up in flames every year. The electricity that is generated accounts for 2.5 percent of Dutch electricity production. But generating energy from waste is not in line with the vision for the future espoused by the Dutch government and European policymakers. Their aim is to create a circular economy in which the systematic reuse of resources is the norm. At the start of this year, the European Commission announced that all plastic packaging must be recyclable by 2030, but it is not exactly clear what that is going to mean in practice. We've got to recycle more intensively but the question that still needs to be answered is, how.

sorting plants: huge halls with conveyor belts on which packaging foils, plastic bags and packaging are sorted into main categories: polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PET), foils and mixed plastics. The plastics are usually shredded and washed to remove dirt. In the sorting and mechanical recycling process, unusable and polluted plastic is left over, and this is incinerated with the rest of the non-recyclable waste.

PLANTS IN AMONGST THE PLASTIC

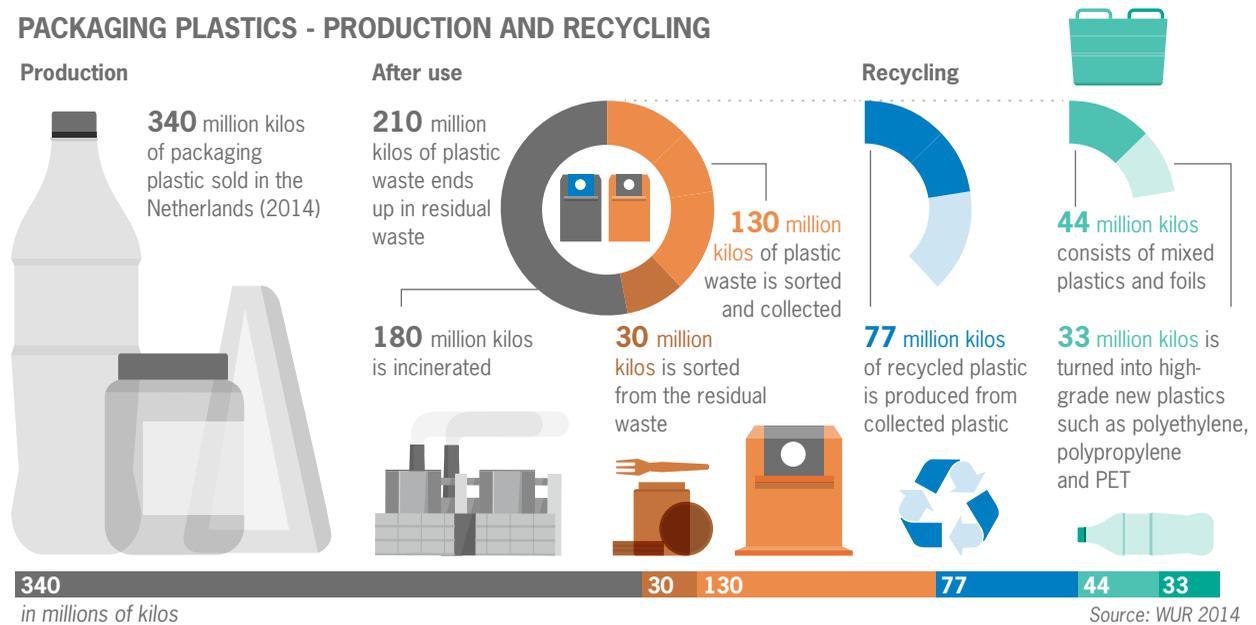
We also throw all sorts of things into the plastic container that do not belong there. 'You find all kinds of non-plastic material in there: metal objects, a bit of glass, some textiles,' says Thoden van Velzen. 'Sometimes that category is small, and sometimes it is very big, even up to 30 percent and including house plants and wine bottles. Also, as well as packaging plastic there is non-packaging plastic such as toys and PVC building materials. This is often as much as 10 percent. What is more, some of the rest of the packaging plastic is not what is wanted, such as blister packs for medication, polystyrene, silicon filler packaging and bottles that have had chemical waste in them.' Then there are food remains such as sour milk or orange juice stuck to the packaging. And to cap it all, one item of packaging is never made of just one kind of material: a bottle usually has a top and a label of a different kind of plastic.

If you look at the kinds of plastic that are wanted for recycling – polyethylene, polypropylene and PET – less than 50 percent of the collected material is left once you've extracted all those contaminating materials, says Thoden van Velzen. Plastic packaging is a very different matter to glass in that respect, because plastic is relatively light compared to the contaminants. 'In glass packaging, the weight of the labels, corks and food remains is relatively light. For plastic and drinks cartons, however, is it really problematic because it often doubles the gross weight of what you collect. That gives a contradiction between what a scientist measures and the official statistics based on gross collected weights.'

MIXED PLASTICS AND FOILS

Contamination and combinations of types of plastic mean that a lot of effort needs to be made to process the waste into pure, clean material. 'An overview of the whole system shows that 340 kilotons of new packaging plastic was marketed in the Netherlands in 2014. The

PACKAGING PLASTICS - PRODUCTION AND RECYCLING



plastic waste collected added up to 130 kilotons, mostly consisting of mixed plastic and foils. The proportion of pure recycled polyethylene, polypropylene and PET is small, while those are precisely what you really need for circular-economy recycling.' Thoden van Velzen's research shows that the separate collection of plastics produced 9.1 million kilos of polypropylene, for example, as opposed to 35 million kilos of mixed plastic. 'For companies that want to purchase recycled plastic, it is very difficult to obtain large quantities of

the recycling of household plastics, you often end up with an element of plastics not intended for contact with food. They can potentially contain nasty substances such as heavy metals from colourants. It's very hard to get a grip on, because when you collect plastic, you get plastic of many different colours. The plastic ends up the same colour as the rubbish bin, and even smells like it. It soaks up the smell of rotting food, and you can still smell it even after it's been processed into a new product.' This smell can only be removed from the plastic with hot water and chemicals, but that is relatively expensive and not every recycling company does it.

'We are collecting more and more, but the system is not perfect'

recycled polyethylene, polypropylene or PET for a reasonable price,' says the researcher. Even if the packaging industry succeeds in sourcing clean recycled plastic, using it to package food is not always allowed, says chemical technologist Karin Molenveld, who does research on the processing of recycled plastics at Wageningen Food & Biobased Research. The regulations for food packaging are quite clear. 'Plastic is not allowed to contain any contaminants that could end up in food if they are in contact with it. In

NEW BOTTLES FROM OLD

The recycling of PET bottles with a deposit on them is an exception to the rule that recycling hardly produces any new food packaging. The collection and processing of these bottles are so well-organized that new PET bottles are made out of old ones. Recycled PET granules are heated to above 200 degrees in vacuum conditions to remove any potential contamination. Molenveld: 'That treatment is specific to PET, and it means you can get rid of anything nasty. The structure of the plastic is repaired, making it suitable again for new food packaging.' The chemical properties of plastics are key to what you can do with them after recycling, says Molenveld. Plastics such as polyethylene and polypropylene absorb grease and odours from waste more readily than PET does, limiting their usefulness for new packaging. Currently, the recycling of household plastics mainly produces mixed products which are processed into items such as sustainable substitutes for tropical >



Sorting the waste in Rotterdam.

hardwood in waterway bank shoring or scaffolding. More decontaminated products can be used for rubbish bags and for the black buckets you can buy at a hardware store.

The limits to the scope for processing plastics into new products do not make recycling pointless, however. The requirements for recycled plastic for packaging items such as wall paint or compost are less strict than those for food. 'But the plastic must still be pretty pure, otherwise you can't process it,' says Molenveld. 'If there is too much of a different type of plastic in the mix, you get holes in a bottle or bucket. Actually there is not enough of that kind of high-quality recycled material on the market. We collect enormous volumes of it, but if you look closely, you can see that there is not much pure recycle available.'

MUCH MORE EXPENSIVE

Another way of organizing the recycling of packaging material is to make use of biodegradable bioplastics. These are not made out of mineral oil, and the waste can go into a digester or a composter. The market for those kinds of plastics is not very big yet in the Netherlands, says Molenveld. 'Maybe half a percent. One of the reasons is the low cost price of standard plastics made of oil. Bioplastic tends to be much more expensive so the consumer has to be really committed to it. And for many consumers, plastic is just plastic,' says the researcher.



'There is a range of applications, such as packaging for organic vegetables, cups at festivals or pots for herb plants. The Coop recently introduced meat trays made of polylactic acid. Another application is the biodegradable bags used to collect organic household waste.'

Biodegradable plastic is a relatively new category of household waste, and it really belongs in a different recycling process: the compost heap. Molenveld: 'It is actually quite possible for waste processors to select biodegradable plastic and put it into the composting process, but they would need sufficient quantities. Composters are keen to dispose of biodegradable plastic cups at festivals, because they are easy to digest into biogas. But if households were to throw biodegradable plastic into the organic waste, the processors would be afraid of contamination with non-biodegradable plastic waste. That is already a problem now. For consumers it is not always clear what is allowed to go in the organic waste bin and what is not. The costs of sifting out contamination mount up because compost has to meet strict quality criteria.'

FERMENTING WASTE

Besides plastic waste, our organic waste is collected in large quantities too. Digesting and composting offer ways of processing organic waste into biogas and compost. But these are quite low-value forms of recycling. Jeroen Hugenholtz of Wageningen Food & Biobased Research is doing research with Spanish colleagues within the EU URBIOFIN project, to find out whether organic waste can be turned into more valuable materials by fermenting the waste using microorganisms.

This is based on the fact that, apart from water, the main constituent of organic waste is carbohydrates such as the woody fibres and cell walls in peel and other food and plant waste. The first step is to break down those carbohydrates into sugars by adding enzymes. 'That mixture is then digested without oxygen, and in the process bacteria convert the sugars into short-chain fatty acids. At that point our technology for making bioplastics comes into play.'

In recent years, a lot of experience has been gained in Wageningen with making polyhydroxyalkanoate (PHA), a substance used by microorganisms for energy storage for times of shortage, but which also turns out to be a perfectly good biodegradable plastic in itself. Two microorganisms are used to do this. The first (*Cryptococcus curvatus*) feeds on short-chain fatty acids

and turns them into long-chain fatty acids. The second microbe (*Pseudomonas putida*) works on long-chain fatty acids to make the bioplastic PHA, which can be purified later.

Hugenholz: 'We know that we can convert more than half the carbon present in the organic waste into plastic. But that is based on ideal circumstances, and the composition of waste can change so you might not always achieve that. We want to investigate that further with this project.'

URBIOFIN has been up and running for a year now. Parts of the process are currently being studied in the lab. Larger scale tests with household waste are expected around 2020. Since the researchers are starting with unsorted Spanish waste, the circumstances will be far from ideal, says Hugenholz. 'But if the technology development with this kind of waste is successful, there is a good chance you can also apply it in countries with a better organized waste-sorting system.'

The sugars from household waste can also be converted into other resources, says Hugenholz. As an example, bio-ethanol is currently being made out of household waste on a small scale in Spain. 'There is also a study going on here, in collaboration with a British consortium, on making butanol and propanol from household waste. These alcohols are of interest as biofuels, and as the basis for conversion into high-value raw materials for the chemical industry.'

INCREASING AWARENESS

Meanwhile, large quantities of household waste are being collected in separate, sorted categories.

Molenveld: 'There is increasing awareness of the benefits of waste-sorting, and increasing quantities of sorted waste are being collected. We are collecting more and more, but the system is not perfect yet. We must communicate about that honestly and openly, otherwise consumers will start wondering whether all their efforts are worthwhile.'

Molenveld says one of the solutions starts at the source: design for recycling, which means avoiding combinations of diverse packaging materials that effectively obstruct recycling. The multi-layered foils used to package crisps, pre-baked bread and processed meats are especially difficult to deal with. Those layers can't be separated later on, explains Molenveld.

'Polypropylene, polyethylene and PET can easily be recycled separately, but as soon as they get mingled together it gets tricky. You can't say: let's just make



'We could use more than half the carbon in organic waste to make plastic'

packaging out of one type of plastic from now on. Because which one should that be? Each plastic has its own unique properties and materials are also chosen for transparency and moisture permeability. There is a lot of talk of "design for recycling" but we are not seeing much of it in reality.' Take cardboard packets of rice with a plastic window in them. If I see them I think: you can also pick up the box at home and feel how much there is still in it.'

STRICTER SORTING

It is time for a rethink, says Thoden van Velzen. 'What are we aiming at? We can leave the waste processing system as it is, but then it will remain difficult for companies that want to purchase recycled inputs to find adequate supplies. We have mainly focused on quantity up to now, and the main achievement is that more sorted waste is being collected. Now it is time to work on the quality of the recycling system.'

This means, among other things, that waste collection companies need to check more stringently whether consumers are actually putting the correct materials in their plastic container. 'Sorting companies should start sorting more strictly than they have been used to doing up to now. Recycling companies should make more effort to create better quality materials out of recycled plastics. And not least, all packaging companies must get serious about design for recycling. There are a few small producers making a huge effort to develop ecologically sound, recycled packaging. And on the other hand, there are the importers for the large retail chains, for whom the design is of no interest because they want to sell a cheap mass product. We've still got a long way to go.' ■

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