FrieslandCampina sees the need to reduce plastic pollution and is willing to take action. Therefore, multiple sustainability goals have been set. One of the goals says: All packaging will be circular in 2050. A lot of years are left to reach this goal, but also, a lot needs to happen. There is a need for insight into the challenges to reach circular packaging and how to overcome them. This thesis aims to assist with this need.

This has been done by firstly centralising the knowledge of gaps that should be bridged to reach circularity. The analysis started with defining circularity and food-to-food recycling and the challenges to reach them coming from regulation. Food-to-food recycling is an important development for circularity, but it has strict rules set by the European Food Safety Authority (EFSA). These are especially tough on polyolefins since they have a hard time with the challenge test that is needed to attain the licence to recycle food-to-food. Dutch regulation hinders progress in recycling. Improving sorting output is not motivated and sometimes even punished. There is no realistic outlook on the EFSA changing regulation in the coming years. Dutch law could be altered to incentivise higher quality recyclate.

Next, the material limitations of packaging types were discussed. FrieslandCampina defined future materials, which are packaging materials that the company expects to use in the coming years. This thesis covers the following: PET bottles, PET trays, PP & PE rigids, PO flexibles, and beverage cartons. Since the amount of products is substantial, improving recycling for every of these packaging types is relevant. Material properties will inevitably drop when packaging is polluted, shredded, and reproduced. Minimising damage with shredding and reproducing has limited potential, but there is a lot to win by lowering pollution. This can be done by producers designing their packaging to better suit the recycling process, but also if sorters and recyclers improve their sorting and cleaning capabilities.

To gain a better image of what happens to FrieslandCampina's future materials after disposal, the recycling process was analysed per packaging type. Every packaging type has potential for improvement, and they're all different. PET bottles have the most potential, but FrieslandCampina's PET bottles are not designed for recycling, and thus, not recycled optimally. The PET trays are currently well on the way to becoming food-to-food recycled. How the trays should be designed for recycling is known and being implemented at the moment, and there is an established tray-to-tray recycling system in the Netherlands. PP and PE rigids have stable recycling routes. Unfortunately, they are always recycled into non-food products. The EFSA gives no expectation to be able to recycle them at a food-grade level. The only possibility as of now would be a closed-loop system. Flexible packaging is a prime example of a linear economy solution. It is either not recycled at all, or recycled into low-value, multi-material, non-food products. Most flexibles have to be multilayers that can't be separated to achieve the needed barriers for food protection, which lowers the value of the recovered material. Besides, the sorting infrastructure is not designed to create mono-fractions of different flexible packaging types. Achieving food-to-food recycling is off the table until chemical recycling becomes an at-scale viable option. The last of the analysed future materials, namely beverage cartons, takes the largest portion of the FrieslandCampina packaging portfolio. In the Netherlands, they are collected with plastic and metal waste. They have a dedicated recycling process where the paper part is recycled into non-food products. The rest is harder to recycle, mainly due to the aluminium part in many beverage cartons. Recycling this 'PolyAl' fraction is new, but the scale at which it is done is rising. Food-grade recycling is not on the horizon yet for this packaging type.

To achieve a circular economy for packaging, there are gaps to be solved in every part of the value chain. The information from the first part of the thesis made it possible to provide structure in the order the gaps should be bridged. This structure is provided in the form of an archetype method, which can be seen as a roadmap with circularity as the destination. The method aims to make it easier to determine the sustainability progress of a packaging type and to inspire projects. With the everchanging recycling industry, the method must be future-proof. This was done by keeping the method general to some extent, but easy to apply to specific packaging. To avoid not being future-proof, time-specific relevant situations that are required to advance in the method were avoided but merely given as suggestions.

As an example of possible applications, the method was applied to FrieslandCampina's Dutch PET bottle and flexible portfolio. These two have the greatest discrepancy in the potential for food-to-food recycling and circularity, and thus, show the largest range. Part of the PET bottle material-specific solution was further validated with external experts and stakeholders to see the feasibility of the proposed solution.

The result of the thesis provides FrieslandCampina's Global Packaging Development team with a method that can improve the synchronisation of knowledge between Technology Expert Teams, give a quick insight into packaging sustainability progress, and inspire the team to start new projects.