# Transition of the mixed plastic household waste value chain

*Almere as case in a multi-level analysis on innovation in the niche of recycling mixed plastics*

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**Abstract**
Packaging plastics account for the majority of the household waste plastics. These plastics can be divided into a number of types of plastics, namely PET, HDPE, LDPE, PP, PS, EPS and others. However, many plastic packages consist of different types of plastics and are often contaminated, therefore these plastics end up in the mixed plastics. While monostreams of plastic waste still have a certain value the mixed plastics are worthless and accumulating. With an ever-increasing amount of mixed plastic waste, it is very important to recycle these plastics too. The EU, the Dutch government and municipalities in the Netherlands all have their sustainability goals. Almere as a municipality in the Netherlands wants to create their own mixed plastic household waste (MPHW) value chain to reduce their total amount of residual waste per citizen.

The aim of this research is to find out how the municipality of Almere can encourage local recycling of MPHW. The research question of this research is therefore: *What are opportunities to stimulate the niche of mixed plastic household waste recycling, in the municipality of Almere, and how can this be organized?*

To answer the research question there is made an overview of the plastic waste recycling infrastructure in the Netherlands and interviews are held with the municipality of Almere and with companies that are active in the recycling of MPHW. To be able to analyze the developments a theoretical framework has been designed which is based on the multi-level perspective, strategic niche management and business model innovation.

The results show that municipalities in the Netherlands, such as Almere, have gained more control over their own waste processing. Almere can stimulate developments in the local niche for recycling MPHW by creating the right conditions such as a guaranteed supply of MPHW and demand for products made from these plastics. Technological innovations in the recycling of mixed plastics can be conducive to the success of the niche when Almere brings the various players together. Successful development of the local MPHW niche in Almere can stimulate other municipalities to follow their example.

## Contents

# 1. Introduction

## 1.1 Context and purpose

In this research the plastic household waste value chain is analyzed, the focus is on developments in the niche of mixed plastic household waste (MPHW) recycling in Almere. Almere is a municipality, in the Flevoland province in the Netherlands, which wants to reduce the amount of household waste and explore opportunities to convert this waste into new resources. In the case of plastic household waste, Almere is searching for opportunities to re-use and/or recycle these plastics into agglomerate or regranulate and subsequently convert them into products that can be used locally. With this ambition the municipality of Almere could proof to be a pioneer in the search for a local circular approach to deal with the ever-increasing amount of plastic waste. This could accelerate a transition in the recycling of our household plastic waste, to start with the mixed household plastics.

Plastics are used for a wide-ranging variety of products in sectors such as packaging, construction, transportation, electronics, agriculture and healthcare. In all these sectors plastics have brought huge economic benefits, due to the low costs of plastics and the characteristics of different kinds of plastics (Andrady and Neal, 2009). By combining unequalled functional properties with low costs, plastics became one of the global materials driving modern economies (Ellen McArthur Foundation, 2017). This success of this relatively new material is illustrated by the exponential growth in production in the last half of the 20$^{th}$ century. Since 1964, when 15 million tons of plastic were produced this amount has doubled every 11.5 years, reaching a total production of plastic of 311 million tons in 2014. Therewith the total production of plastics has already been twenty-folded. Expectations regarding the amount of produced plastic estimate that their production will be doubled within a period of 15 years (UNEP, 2014). The plastic market is still growing but not as fast as before. A large amount of plastics, 26 percent of the total production of plastics, is used for packaging as they are especially inexpensive, lightweight and high performing (Ellen McArthur Foundation, 2016). Plastics have stimulated prosperity and substituted numerous products because of their beneficial characteristics. One of these characteristics is that most plastics are also perfectly suitable to recycle. Nonetheless, plastic product chains are still typically linear and their 'take-make-dispose' value chains involve major economic and environmental drawbacks. Nowadays, only 14 percent of all the plastic packaging is collected globally. The negative impacts of disposal, across the entire range of plastic products, emphasize the necessity to fundamentally rethink the global plastics system (Ellen McArthur Foundation, 2017).

Since the start of 2018 China implemented an import ban on plastic waste (Lee, 2018). Whilst China cannot be used as our waste dumping ground anymore, the recycling of our own waste has become an even more important priority. The European Commission announced they will propose new rules for all EU member states targeting ten single-use plastics, the ten that are most found on Europe's beaches and in Europe's seas, stating: "*We will ban some of these items, and substitute them with cleaner alternatives so people can still use their favourite products*" (European Commission, 2018). Following this statement the European Parliament approved a ban on a range of single-use throw away plastics by the year of 2021.

In the Netherlands, the Dutch Ministry of Infrastructure and Water Management (MIWM) set the goal to enhance the transition towards a CE (Ministerie van Infrastructuur en Milieu 2013; 2014; 2015). To do so attention is situated on five priorities of importance for the Dutch economy: (1) biomass and food; (2) plastics; (3) manufacturing industry; (4) construction; (5) consumer goods. It is the ambition of the Dutch to make the Netherlands global leader in the field of circular economy (CE) in these sectors by the year 2020 (Ministerie van Infrastructuur en Milieu, 2016). For the plastic household value chain this ambition can be defined as: "the priority is to reuse plastics and use fewer primary resources, consequently have less plastic waste and emissions, and eventually create a

sustainable value chain where new value and employment is created". In this ambition a CE of plastics is the goal and opportunities that make the reuse and recycling of plastics possible should therefore be analyzed.

## 1.2 Problem statement

Strategic niche management (SNM), as a tool for policy, models the dynamics of niche development. Van Eijck and Romijn (2008) define a *niche* as: "a temporary protected space where new innovative technologies can incubate and become viable through experimentation and learning by actors in the network". In the niche level, business model innovation (BMI) of niche companies can take three different roles in which they can stimulate socio-technical transitions (Bidmon and Knab, 2014). The SNM tool is combined with the multi-level perspective (MLP). The MLP distinguishes three analytical levels: (1) the micro-level where niches are and where radical innovations emerge, (2) the meso-level that is shaped by the socio-technical regime and (3) the macro-level that is shaped by the socio technical landscape (Van Eijck and Romijn, 2008; Schot and Geels, 2008).

The relevance of this study to Industrial Ecology (IE) can be found in the search for a new allocation for household waste plastics. It is important to search for ways to reduce the impact of these plastics and increase their usability, so that fewer primary plastics will be needed and fewer plastics will end up in our waste.

This research has been performed in collaboration with Royal HaskoningDHV and the municipality of Almere. Almere wants to move towards a zero-waste future and is keen to experiment with innovative niches in order to reach goals that are set by the EU and the Dutch government. This research will analyze the developments within the niche of MPHW in Almere and will look at these developments from a multi-level perspective.
Municipalities, such as Almere, try their best to reach sustainability goals but have to deal with future recycling contracts and compensations that are unclear and consequently uncertain. This uncertainty complicates incentives for innovation in the plastic waste value chain, while significant gains need to be made within this system. For example, a big municipality and city such as Amsterdam collected 278.8 kg residual waste and 2 kg plastic packaging waste per citizen in 2015. A smaller municipality such as Almere had 180.4 kg residual waste and 21.7 kg plastic, metal and beverage packaging (PMD) waste per citizen in 2015 (CBS Statline, 2016). With these extensive differences in amounts of plastics collected and thus lost potential for their recycling it is essential to assess the role of different actors in the plastic waste value chain and seek for opportunities for the reuse and recycling of household plastic waste. Niche innovations that give value back to the mixed plastics, these plastics are currently considered worthless and have a negative market value, are needed to make the transition towards a more sustainable and circular value chain. Niche innovations are defined as: 'innovations that come from minor groups of actors which have a high potential to change the normal course of affairs'. Niche innovations are usually not stable and require protected spaces to fulfill their potential (Geels and Schot, 2007). Almere set their goals but the means by which to reach these goals are, unfortunately, less clear. Companies within the niche of MPHW could prove to be one of the means in this transition.

Almere wants to become a 'city without waste'. To do so, Almere is open to investigate all means that are available to achieve this. However, waste recycling is a new and unknown field of development for Almere and the way to go is therefore not always clear. Almere wants to experiment with opportunities to recycle their own plastic household waste locally. Within this approach multiple companies that see opportunities for business in the plastic household waste of Almere are involved. These companies are interviewed and asked for their motives, insights, opinions, expectations and their business model. This research analyzes the opportunities of Almere and the companies in the MPHW niche to stimulate the transition to better recycling practices.

## 1.3 Research aim

This research analyzes innovative companies that act within the local MPHW niche in Almere to determine how they can stimulate the recycling of mixed plastics and consequently the transition towards a circular plastic value chain. Almere is a leading municipality in their approach to reach sustainability goals and is one of the first to take a lead role, top-down, to experiment locally with niche innovations within their own household waste value chain. A combination of the SNM, BMI and MLP theory will be used to get an understanding of the interactions between the different actors and developments. Thereby this research will provide insights that are of value for municipalities, such as Almere, to stimulate future recycling practices of plastic household waste.

## 1.4 Research question and subquestions

It is important to get an overview of the plastic waste value chain, the institutions and infrastructure that are in place to be able to determine their influence on developments of the MPHW recycling niche. Following this overview, a case study is performed in the municipality of Almere, to answer the following research question:

*What are opportunities to stimulate the niche of mixed plastic household waste recycling, in the municipality of Almere, and how can this be organized?*

The literature review includes the main concepts that are important to this research. To answer the main question the following subquestions are drawn up:

A. *What are the main developments within the plastic household waste value chain in the Netherlands?*

It is important to first get a view of the overall household plastic waste value chain to determine opportunities in the MPHW value chain. The municipality of Almere, amongst others, has set their goal for a zero-waste future. In their way towards this goal developments within the plastic household waste value chain are of significance. It is therefore important to map the developments that affect the value chain on multiple levels: the landscape, regime and niche. These include agreements regarding the processing of plastics, the direction the market moves and available technology and infrastructure. Subquestion A is mainly covered by the literature review that elaborates on the current course of events, regulations and main actors in the plastic waste value chain.

The next subquestion is focused specifically on the niche and is as following:

B. *What are promising innovations in mixed plastic household waste recycling in the Netherlands?*

For Almere the in the processing and/or use of recycled plastic is an unknown field of experience. To be able to make a deliberate choice it is important to know what are innovations in the recycling of plastics and use of recycled plastics. The companies that have their interest in the processing of mixed plastics could stimulate the development of the MPHW niche. Interactions between the different actors within the niche are evaluated on their expectations and visions, social network, and learnings. To assess the role these companies can potentially play, in the development of the MPHW niche, their business models are analyzed. Information to answer this subquestion is obtained from qualitative interviews with innovative niche companies such as Upp! UpCylce Plastics, Save Plastics, InGarden, MEPPP, BlueAlp, Polytential and Recycling Avenue.

The last subquestion is:

C. *How can Almere facilitate and stimulate the recycling of mixed plastic household waste?*

It is important to see what forces from the landscape and regime affect developments on the niche level and to what extent Almere can facilitate and stimulate further development of this niche. To assess the role Almere can play in the development of the local MPHW niche the different niche companies are compared.

## 1.5 Scope

The scope of this research is the local MPHW niche in the Dutch municipality Almere. Almere wants to become a 'city without waste' and sticks to a progressive agenda to reach this goal. In Almere there is an area, the Vijfhoek, available for pioneering companies to experiment and develop. In this research attention will be foremost on the innovative companies in the MPHW. These companies could play a major role in the realization of a local MPHW value chain in Almere.

# 2. Literature review

This chapter contains the theoretical framework of this research. First the relevance of the circular economy (CE) will be explained and main concepts and objects such as, plastics, the packaging industry, institutions, and plastic waste recycle technology of interest for this research will be set out in the background section. Secondly, the theory review will elaborate on previous research that is performed using strategic niche management (SNM), the multi-level perspective (MLP) and business model innovation (BMI) as theoretical background. These theories will be used in this research to analyze the household plastic waste value chain.

## 2.1 Background

### 2.1.1 Circular Economy

Boulding (1966) was the first to write about a CE as a "cyclical ecological system which is capable of continuous reproduction of material form even though it cannot escape having inputs of energy". The concept of CE is deeply embedded in the field of industrial ecology (IE). Robert Ayres was the first to introduce the concept of industrial metabolisms "at the most abstract level of description, then, the metabolism of industry is the whole integrated collection of physical processes that convert raw materials and energy, plus labor, into finished products and wastes in a (more or less) steady-state condition" (Ayres, 1994). The function of a CE is to achieve a state that looks like nature where the system would be featured by a "complete or nearly completely internal cycling of materials" (Ayres, 1994).

CE accentuates the benefits of recycling by-products and residual waste materials. A CE is beneficial because it will reduce the amount of waste by recycling this waste and will thereby reduce the amount of virgin materials that are needed for production. However, in a CE attention is mostly based on physical observations rather than economic observations because the gains of a CE are foremost aimed the minimization of material loss (Andersen, 2007). To reach circularity new concepts of products together with new business models and value chains need to be (re)designed. Our society is abundant in systems of social rules that structure interactions between actors and their environments. These systems can also explain the delays or even failures of promising niches. It shows that we should not always rely on the invisible hand of the market when the realization of long term sustainability is the objective (Schot and Geels, 2008; Geels 2002; Tukker, 2016).

The CE is a new concept away from the linear economy. A linear economy can be described as an economy where businesses extract materials, apply energy and labor for their production and subsequently sell it to consumers whom will dispose the product when it has no use anymore. At the start of this millennium prices of natural resources began to rise again for the first time, counteracting a whole century of price declines. The first decade of the 21$^{st}$ century is characterized by price higher volatility levels for metals, food, and non-food agricultural output than any of the decades in the 20$^{th}$ century. As world population keeps growing and urbanizing consumption levels will rise along and resources need to be extracted from harder-to-reach locations. This goes along with an increase in environmental costs because natural capital is depleted. The CE is a new model where the aim is to break the relation between sales revenues and material input by using a restorative industrial economy. In such a CE the design of products take ease of reuse, disassembly, refurbishment, remanufacturing and recycling into account (Ellen McArthur Foundation, 2017).

### 2.1.2 Current waste practices

In the 28 EU member states (EU-28) plus Norway and Switzerland the total demand for plastics was 47.8 million tons in 2014 and 49 million tons in 2015, of which the packaging industry amounted for 18.8 million tons (39.5 %) in 2014 and 19.1 million tons (39 %) in 2015 (PlasticsEurope, 2015; PlasticsEurope, 2016). This demand only accounts for the industries producing plastic containing products within Europe; plastic products that are exported or imported are not compensated for. In

the EU-28 the total amount of plastic packaging waste was 15.3 million tons in 2014. From this 15.3 million tons only 10.8 million tons (70.3 %) were recovered and 6.1 (39.6 %) tons recycled (Eurostat, 2017). The amount of recovered plastic waste (10.8 million tons) is 42.5 percent less than the demanded quantity of plastics for packaging (18.8 million tons). In the Netherlands the total amount of plastic packaging waste generated, as a separated flow, amounted 474.000 tons in 2014. From this plastic waste 463.750 tons (97.8 %) were recovered and 323.000 (68.1 %) recycled (Eurostat, 2017). These numbers indicate that the Netherlands is committed to collect and separate the plastic packaging waste streams appropriately and work towards a CE of plastics. The household plastics that are collected and processed by the waste processors are separated into several streams to know: Polyethylene (PE), Polypropylene (PP), Polyethylene terephthalate (PET), foils (mix of PE and PP plastics), and mixed plastics. In 2015 the ratio of these different streams, before entering the sorting installations of the waste processors, were as following: PE (9.2 %), PP (11.5 %), PET (8.9 %), foils (23.8 %), and mixed plastics (46.6 %) (TNO, 2017). The first three streams (PE, PP, PET) are mono-streams and exist of one kind of plastic, the foils stream is mainly PE and PP. These streams can be sold on the market for recyclates after they are separated and cleaned by the waste processors. For these mono-streams there a various collectors and suppliers in the Netherlands (NRK Recycling, 2016). However, for the mixed plastics stream there are no companies in the Netherlands that are able to convert these mixed plastics into recyclate and/or products. As a result most of these plastics are exported to Germany. In 1991 Germany already introduced the 'Duales System Deutschland' (DSD) for a separate collection and processing of plastic packaging, drink cartons and metal packaging (PMD) from household waste. With the introduction of the DSD, Germany has 20 years of experience regarding the processing of the mixed plastic waste. However, part of the mixed plastics is also used for energy utilization, where in Germany 36 percent material reuse is the legal standard. Because of this standard, the use of mixed plastics for non-energy purposes has stagnated since 2004. Currently there are 20 to 30 companies (i.e. MTM, Relux, Borchers) that reprocess the mixed plastics into agglomerate or regranulate. They, in turn, supply five major players (i.e. CABKA, Hahn Kunststoffe, Purus Plastics) whom make products out of the agglomerate and regranulate (TNO, 2017).

### 2.1.3 Plastics

Plastics are materials that are made from a broad variety of synthetic or semi-synthetic organic mixes that are flexible and can be molded into solid objects. Plastics mostly exist of organic polymers with a high molecular mass. Plastics are most commonly derived from oil. This section will further elaborate on the different sources of oil as well their origin. Furthermore different kinds of plastics, thermoplastics and thermosets, will be explained. The kinds of plastics that are mostly found in our products will be appointed for on their characteristics.

#### *Oil*

Oils include a range in classes of chemical compounds that can be different in their structure, properties and uses. Oils can be from organic or petrochemical origin and can be both volatile and non-volatile. Oils are used for a whole variety of products such as food, fuel, medical purposes and the manufacturing of various kinds of goods such as paints and plastics.

Organic oils are oils that are made from plants, animals and other organisms by metabolic natural processes.

Petrochemical oils are oils that are produced from crude oil and are a crucial resource in our current modern economy. Millions of years ago large oceans covered much of our planet's surface, filled with plankton and algae. The death plankton sank to the ocean's seabed and was suppressed in layers of sediment. These sediments became deeper and the temperature and pressure increased. These geochemical processes converted the plankton into petroleum (crude oil) and natural gas (mainly

methane and ethane) over time. Worldwide there are hundreds of different crude oil sources all of them with their own unique composition (PlasticsEurope, 2017a).

### *Distillation of naphtha*

Crude oil is a complex mix consisting of thousands of mixtures. To be of use for us crude oil needs to be processed. The production of plastics always starts with a distillation process in an oil refinery. In the distillation process of crude oil, heavy crude oil is heated and converted into a gas. As the gas cools different fractions in the gas that have different boiling temperatures are condensing back into separate liquids. These separated liquid fractions are mixtures of hydrocarbon chains (chemical compounds consisting of carbon and hydrogen) and have a different structure of molecules. Naphtha is one of these fractions; naphtha is the crucial element to produce plastics. As there are hundreds of different crude oil sources, consequently there are also numerous kinds of naphtha's with their own unique initial and final boiling points and other compositional and physical characteristics (PlasticsEurope, 2017a).

### *Cracking*

The next step in making plastics is the cracking of the naphtha. Cracking is a thermal chemical process in which a chemical mixture, usually organic, is broken down (cracked) into simpler mixtures. Within the cracking process naphtha is being broken down into smaller hydrocarbon molecules, such as ethylene, propylene and butylene (PlasticsEurope, 2017a).

### *Polymerization*

Hydrocarbon molecules such as ethylene and propylene are the common building block of plastics. Polymerization is a chemical reaction where a large number of individual molecules are connected to form a polymer chain (PlasticsEurope, 2017a).

### *Thermoplastics and thermosets*

The structure of the polymer chain determines the kind of plastic and their physical characteristics. There are two different kinds of polymer families: thermoplastics and thermosets.

Thermoplastics soften when they are heated. Because the molecules in thermoplastics are separate from each other they can move about easily at higher temperatures. Thermoplastics can in all cases be melted and reshaped an infinite amount of times.

Thermosets can only be molded once. When thermosetting polymers are molded, additional chemical bonds are created between the molecules producing a three dimensional strongly woven network. These additional chemical bonds make re-melting and reshaping of thermosets impossible (PlasticsEurope, 2017a).

In table 2.1 examples of thermoplastics and thermosets are given.

Table 2.1. Examples of thermoplastics and thermosets

| Thermoplastics | Thermosets |
|---|---|
| Acrylonitrile butadiene styrene – ABS | Epoxide – EP |
| Polycarbonate - PC | Phenol-formaldehyde - PF |
| Polyethylene - PE | Polyurethane - PUR |
| Polyethylene terephthalate - PET | Polytetrafluoroethylene - PTFE |
| Poly(vinyl chloride) - PVC | Unsaturated polyester resins - UP |
| Poly(methyl methacrylate) - PMMA | |
| Polypropylene - PP | |
| Polystyrene - PS | |

Expanded Polystyrene - EPS

### *Mechanical recycling*

First of all, there exist two kinds of recycling: mechanical recycling and chemical recycling. Currently majority of the recycled plastic waste is mechanically recycled. Chemical recycling is still in its infancy but seems to be a promising way of recycling in the future.

With mechanical recycling, plastics are separated with machines by means of different processes. There are different streams of waste plastics, some plastic waste streams that come from companies are already one kind of plastic, contain pollution and are easier to recycle than household plastics. Because plastics in the household plastic waste are all mixed up, they need to be sorted on their kind and/or additives (e.g. fire retardants) by the use of identification systems. These systems range from manual sorting and picking of the plastic materials to mechanic automated processes involving shredding sieving, separation by density (air, liquid, magnetic) and more complex technologies (UV/VIS, NIR, Laser). After these first sorting processes the plastics are sorted on their color. Next they get shredded into little fragments, these fragments undergo cleaning processes to eliminate impurities. After all these processes the plastics recyclables are melted and compounded in the shape of pellets that can again be used for the manufacturing of products (PlasticsEurope, 2017b).

### *Chemical recycling*

Chemical recycling is a collective name for a number of technologies to disassemble molecules. The technologies have an increasing range of processing temperatures and every technology has different products. Within the chemical recycling there exist solvolysis, glycolysis, pyrolysis and low temperature gasification.

Solvolysis is technically speaking a process of physics because it is about solving and is not a chemical process. With this technique plastics and additives can be separated from each other and both of them can be reused, just as the solvent. Solvolysis is a niche development already being picked up by the market. A good example of this Polystyrene Loop, which is a cooperative with fifty participants from eight European countries, that has built a demo plant for construction-related Polystyrene (PS) in Terneuzen. This process is also promising for the recycling of multi-layer plastic products (PlasticsEurope, 2017d).

With glycolysis (depolymerization) polymers are converted into monomers through adding heat and chemicals. This way impurities are removed. Ioniqa, in Eindhoven applies depolymerisation for the processing of used PET (PlasticsEurope, 2017d).

Pyrolysis is the technique of heating plastic waste in the absence of oxygen. The products of pyrolysis are fixed (carbon), liquid (pyrolysis oil) and gas.

Low temperature gasification is the technique of heating plastic waste to temperatures between 700 up to 900 °C. There is a limited amount of oxygen necessary for gasification. The temperature is limited because that way more valuable components can be retained. The product of this technology is mainly gas.

Pyrolysis and low temperature gasification are considered as the most promising technologies for mixed plastic waste. The strength of these two technologies is that they are able to recycle the waste stream, containing contaminants and other pollutions, from the mechanical recycling into new resources. Because in both processes of pyrolysis and low temperature gasification there is always heat generated, energy needed for the installations, catalytic conversion steps are required and a variety of products is generated the saving of these techniques will never be 100 percent (ECN, 2017).

Because not all plastics are and can be separated into mono-streams there exists a waste stream of mixed plastics, and this stream is actually the largest stream of household plastic waste. Currently these mixed plastics are considered worthless. The problem that arises with these mixed plastics is that as different kinds of plastics are melted together they have the tendency to phase-separate, like oil and water do, and set in layers of plastics. These phase boundaries (different melting temperatures for a change of phase) can cause weaknesses in the resulting material. Because of these restraints there is only a limited amount of applications for these mixed plastics (Creton, 2017).

When plastics are well separated as mono-streams there arise opportunities for distributed recycling. Waste plastics such as PET and HDPE can be used to make filament for 3-D printers. Especially when this is done in rural areas this is favorable over the use of virgin or conventional recycling processes, primarily because of major reductions in transport (Kreiger et al., 2013; Kreiger et al., 2014).

### 2.1.4 Institutions, legislation and covenants

In the Netherlands there is different legislation in place regarding plastic household waste. First of all there is EU legislation that is binding for the Netherlands; secondly there are national legislations and agreements that further elaborate on the EU legislation. In the following section EU legislation and Dutch legislation will be précised.

#### *Legal acts of the European Union*

Legal Acts of the European Union (EU) are acts that are implemented by the Institutions of the EU to exercise the powers given to them by the Treaties of the EU. These Treaties of the EU consist of a set of international treaties between the EU member states and sets out the constitutional basis of the EU. There exist different forms of legal acts: regulations, directives, decisions and recommendations.

A regulation is a legal act of the EU; a regulation has to be enforced as law in all EU member states. A directive is also a legal act of the EU but a directive requires EU member states to achieve certain goals but does not dictate the means to reach these goals. Thereby a directive can be distinguished from regulations that are self-executing and do not need any measures for their implementation. Directives most of the time leave member states a certain amount of freedom as to the exact rules that need to be adopted. A decision is a legal instrument that by EU law is binding upon those member states or individuals they are addressed to. Recommendations are without legal force but are negotiated and voted on according to the appropriate procedure. Recommendations are instruments of indirect action that aim for regulation in member states (Treaty on the Functioning of the European Union, 2012).

In the case of plastic household waste there are multiple directives in place that are worth mentioning. The directives are summarized and can be found in Appendix A.

First there is the directive on packaging and packaging waste (Directive 94/62/EC) which has the aim to harmonize national measures regarding the management of packaging and packaging waste. This is in order to prevent any impacts on the environment of the member states as well as third countries or to reduce such impacts, thus providing a high level of environmental protection while on the same time ensuring the functioning of the internal market. ‘Packaging’ is defined as all products made of any materials of any nature to be used for the containment, protection, handling, delivery, and presentation of goods, from raw materials to processed goods, from the producer to the user or the consumer. ‘Non-returnable’ items used for the same purposes shall also be considered to constitute packaging.
Secondly there is the directive on waste (Directive 2008/98/EC) providing in measures to protect the environment and human health by preventing or reducing the adverse impacts of waste generation and management and by reducing overall impacts of resource use and improving efficiency of this

use. ‘Waste’ means any substance or object that the holder discards or intends or is required to discard.
Lastly the directive on waste from electrical and electronic equipment (Directive 2012/19/EU) exists. This directive provides measures to protect the environment and human health by preventing or reducing the adverse impacts of waste, from electrical and electronic equipment (WEEE), generation and management and by reducing overall impacts of resource use and improving efficiency of this use. ‘Electrical and electronic equipment’ (EEE) means equipment that is dependent on electric currents or electromagnetic fields in order to work properly and equipment for generation, transfer and measurement of such fields and designed for use with a voltage rating not exceeding 1.000 volts for alternating currents and 1.500 volts for direct current. However, this directive is on electronic equipment and should ideally not end up in the household waste streams.

### *Dutch packaging covenant*

As the directives from the EU are obligatory for the Netherlands, the Ministry of Infrastructure and Water Management (MIWM) agreed to the packaging covenant (2013 – 2022) (Raamovereenkomst Verpakkingen) in collaboration with the Dutch packaging industry (Ministerie van Infrastructuur en Milieu, 2014). This covenant is regarding waste that originates from packaging of products and legal requirements producers and importers of these products have. Packaging is defined as following: all products, made from materials of any kind, which can be used for the containment, protection, handling, delivery and presentation of other products, from raw materials to finished products, including the entire trajectory from producer to user or consumer, disposables designed and intended to be filled at some point, packaging solely comprise sales packaging or primary packaging, secondary packaging, and shipping or collecting or tertiary packaging (Ministerie van Infrastructuur en Milieu, 2013b)

The covenant accounts for packaging that is made from: glass, paper and cardboard, wood, metals, and plastics. The packaging industry is held accountable to take care of a robust and sufficient financing system that provides in a fund, composed of waste management contributions that are levied on the basis of a common agreement, from which all necessary activities for the performance of this covenant are paid. The fund has to be sufficient for all these activities and does not limit the quantity of material that is collected. Charges for plastics, metals, paper and cardboard, wood, and glass are indexed annually on the 1$^{st}$ of January (Ministerie van Infrastructuur en Milieu, 2014).

The packaging covenant between the Dutch government and the packaging industry does not legally oblige companies that place packaged products on the market to contribute to the recycling of those packaging, they only agreed to do so in the covenant. The Waste Fund Packaging (Afvalfonds Verpakkingen) is founded to take care of the tasks on behalf of the packaging industry. The fund is financed by contributions that are paid by the packaging industry. The funds main task is to provide in the collective implementation of the obligation the packaging industry has under the packaging covenant. The Waste Fund Packaging does carry out all tasks and objectives itself. Various activities are invested in various organizations like Nedvang and Schoon Nederland. For the preservation and improvement of packaging, an independent foundation has been established: the Institute for Sustainable Packaging (Afvalfonds Verpakkingen, 2017). The Institute for Sustainable Packaging started to investigate the plastic chain and the mixed plastic chain, in the Netherlands in 2016 and 2017, to provide insight into the possible interventions to achieve the ambition of the 2013-2022 packaging covenant.
Nedvang (NEDerland Van Afval Naar Grondstof) is also established by the packaging industry and directs the collection and recycling of different types of packaging waste. For each different stream of plastic packaging waste an amount per kiloton is set for compensation. The compensation is only given if the collection and recycling of these plastic streams meet certain conditions.

Recycling Netwerk (2018a) evaluated the Dutch packaging covenant and recommended the Dutch government to terminate the covenant for various reasons:

- agreements of the covenant are structurally not complied with, especially by the companies, but in some respects neither by the State Secretary;
- definitions and standards are not integrated in legislation, therefore they cannot be enforced and all actors are free to give their own interpretation;
- goals have not been made accountable;
- the Dutch government is no longer part of the KIVD, therefore the question arises what the future value of the KIVD is, as a spokesperson of the industry;
- the KIDV did not fulfill their major pretensions;
- sustainability plans of the industry are marginal and do not cover all materials and packaging that are used.

On the basis of these findings it can be concluded, to the extent of innovation and environmental efficiency, the packaging covenant has proven to be an insufficiently workable and insufficiently binding instrument. Moreover, the breaches of the covenant have been so fundamental and diverse that there really is no good excuse. When the Dutch government really wants to make the transition towards a CE it is of great importance they take control again. Clear and enforceable rules regarding the design and minimization of packaging need to be formulated, covering all types of materials, and where the producer responsibility is concretely worked out (Recycling Netwerk, 2018b).

At this moment the covenant is in place and has set several conditions for the recycling of plastic packaging. One of these conditions is that a minimum of 45 percent of the sorted plastics needs to consist of the following mono streams: Polyethylene terephthalate (PET), Polyethylene (PE), Polypropylene (PP), Expanded polystyrene (EPS), and foils. The leftover stream that is not separated into mono streams consists of mixed plastics. Mono streams of plastics have a value on the market and can be sold. However, the mixed plastic stream is considered to be valueless and Nedvang even pays an amount for the marketing of this stream to prevent incineration.

Another condition is that all these different streams of plastics have to meet certain quality requirements set by the German Society for Plastics Recycling (Deutsche Gesellschaft für Kunststoff-Recycling) that are a leading actor in the recycling of plastics. These requirements apply for every mono stream as well as for the mixed plastics stream and are known as the DKR requirements. The whole requirements can be found in Appendix B. For the separated plastic waste streams the DKR requirements that are set can be found in table 2.2.

Table 2.2. DKR requirements per plastic stream

| Plastic stream | DKR requirement |
|---|---|
| **PET** | DKR-328-1 |
| **PE** | DKR-329 |
| **PP** | DKR-324 |
| **Foil** | DKR-310 |
| **EPS** | DKR-340 |
| **Mix** | DKR 350 |

When the sorted plastics meet the requirements and can be packed for further processing Nedvang will pay compensation per ton (1000 kg) of plastic. This compensation is getting less each year as municipalities improve their collection systems and more plastic is recovered. Table 3 shows the compensation Nedvang pays the municipalities for the collection and recycling of the plastics.

| Year | Compensation per ton | Compensation marketing per ton* | Total |
|---|---|---|---|
| 2015 | € 817 | € 65 | € 882 |
| 2016 | € 788 | € 65 | € 853 |
| 2017 | € 756 | € 65 | € 821 |
| 2018 | € 712 | € …? | € 712 |
| 2019 | € 656 | € …? | € 656 |
| 2020/2021 | € …? | € …? | € …? |

Table 2.3. Nedvang compensation per year (UMP, 2016).
* Costs associated with the organization of the marketing of the plastics (€ 15 / ton); Costs associated with the transport of the marketing of the plastics (€ 20 / ton); Sales or revenue due to the sale of the plastics (€ 30 / ton).

In figure 2.1 municipalities are shown according to the amount of plastic they collect each year per citizen in 2015. There exist major differences between the amount plastics that municipalities collect.

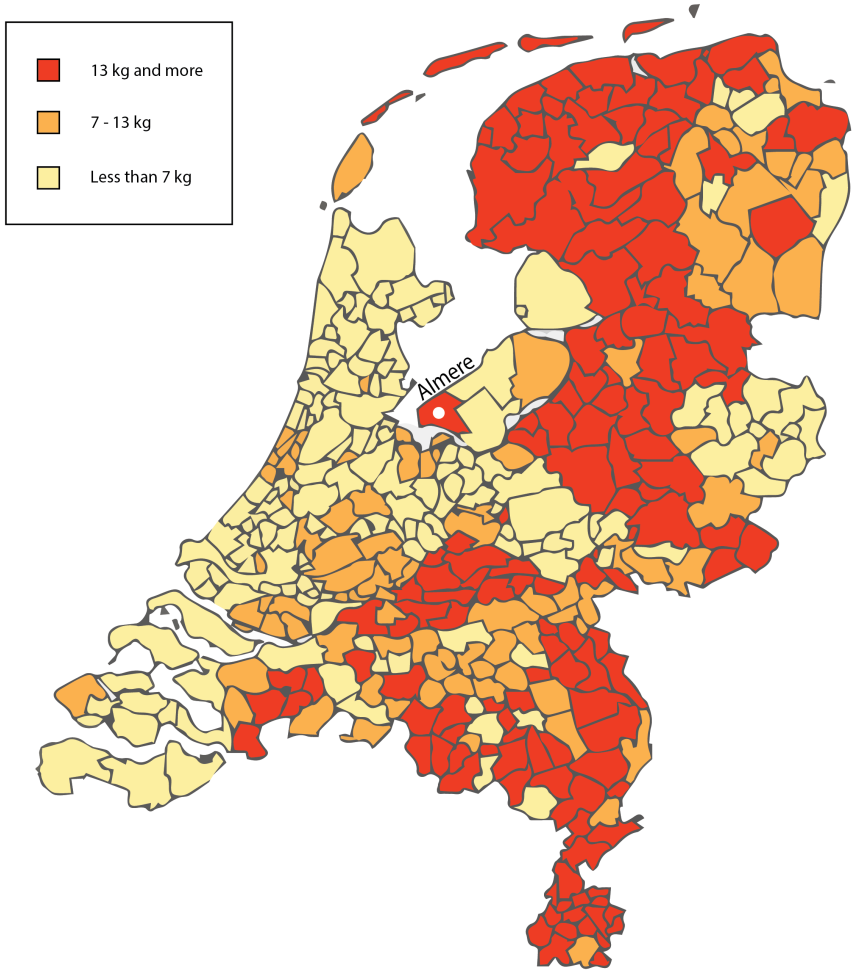


Figure 2.1. Municipalities classified according to the amount of plastic waste collected separately per citizen (Nedvang, 2015).

### 2.1.5 Dutch packaging industry

The total revenue of the Dutch packaging is hard to estimate because there are not a lot of figures available. The Waste Fund Packaging does register the amount of packaging that end up on the Dutch market. These are both packaging manufactured and used in the Netherlands as used packaging from products imported from abroad; Dutch exported packaging is thus not included in these figures. In figure 2.2 the packaging that ends up on the Dutch market is presented. The weight is in kiloton (kton) and packaging is mostly made from paper and cardboard, glass, plastic, metal, and

wood. As found in the figure the total kton of plastic packaging that ends up on the Dutch market is slightly growing in weight and was 504 kton in 2016 (ABN AMRO, 2017).

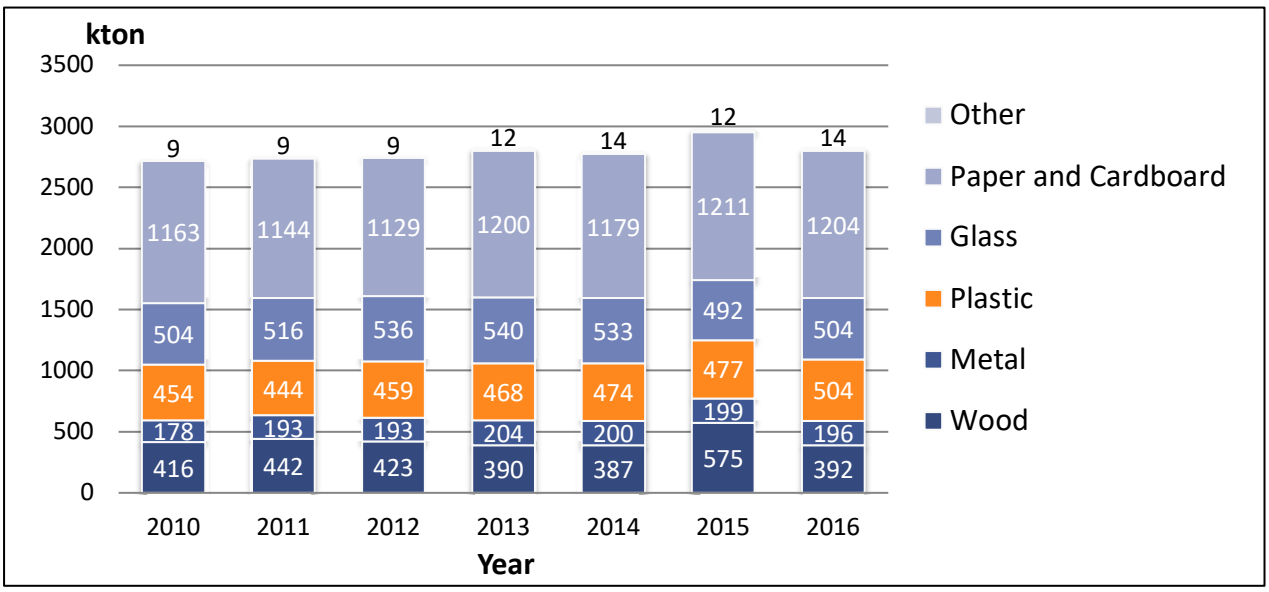

Figure 2.2. Packaging that ends up on the Dutch market in weight (kton) (ABN AMRO, 2017).

Subsequent to the slight growth of the plastic packaging on the Dutch market (around 9 % from 2010 to 2016) developments in packaging practices need to be pointed out: in the 10 years between 2006 and 2016 plastic packaging has been reduced in weight with circa 28 percent (PlasticsEurope, 2017c).

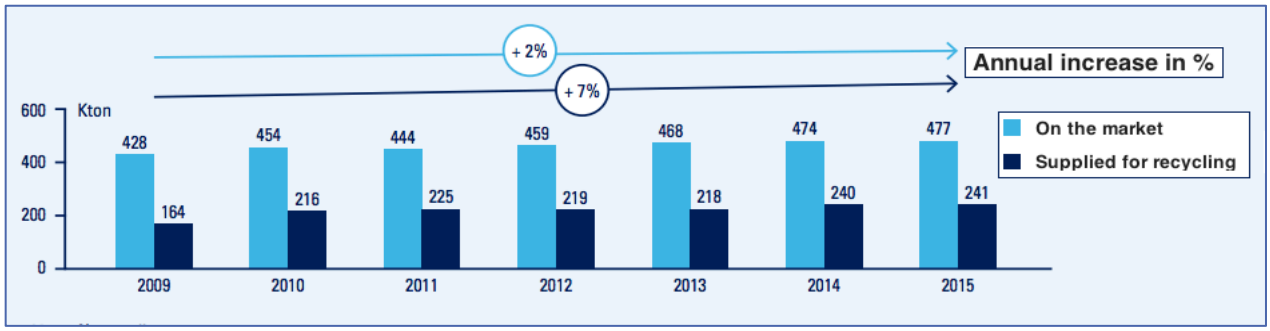

Figure 2.3. Plastic packaging in the Netherlands; amount on the market in Kton, amount supplied for recycling in Kton from 2009 until 2015 (PlasticsEuropes, 2017d).

As shown in figure 2.3 the amount of plastic packaging that is supplied for recycling only totals half of the amount of plastic packaging that is brought on the market each year. The total weight of the packaging plastics has grown with only a few percent each year. However, improvements in the packaging brought considerable reductions in their weight. Therefore it can be assumed that the number of packaging plastics has grown with more percent than the percentage by which their total weight has increased. The total revenue of the packaging industry in the Netherlands is estimated at 6.3 billion euro (figure 2.4). The plastic packaging industry in the Netherlands accounts for 43 percent of the total revenue and is estimated at 2.8 billion euro (ABN AMRO, 2017).

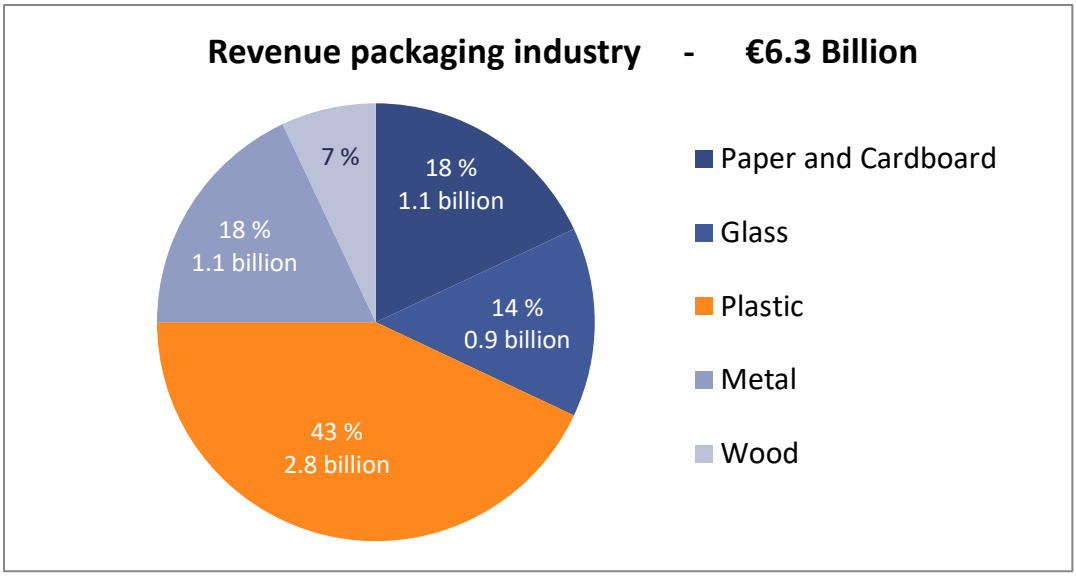

Figure 2.4. Revenue of packaging industry per packaging material in euros (ABN AMRO, 2017).

### 2.1.6 Waste systems

Throughout the Netherlands most different waste streams such as plastic, paper, glass, metal, biodegradables, wood, small chemical, electric and electronic equipment (EEE), and others are collected separately. For households, a separate waste collection system with waste bins for paper, glass, plastic, biodegradables, and residual waste exists. Also waste collections points for EEE and services for other waste streams such as wood, chemical, demolition, bulky waste are in place. However, household waste consists of a lot of plastic products other than plastic packaging such as cd-covers, pencils, tooth-brushes, clothing, tools, etc. Less information regarding the recovery and recycling of these other plastics is available because they are not supposed to be collected in the plastic bin, only intended for plastic packaging, and therefore most often end up in the residual waste. Residual waste is all waste that does not belong in any of the separated waste collection bins. In the Netherlands in most municipalities residual waste is being incinerated in a waste to energy incinerator, this energy is used for the generation of electricity or/and district heating (Milieu Centraal, 2017). There are thus different destinations (plastic) waste has value in the household waste value chain.

Municipalities are free to manage their own waste management; as a result there exist multiple systems in the Netherlands for the collection of plastic household waste. Municipalities choose their own waste management and are free in the determination of the waste tax they apply to their residents. The costs municipalities make for the collection and processing of household waste are mostly covered by the waste tax. In figure 2.5 the waste tax per municipality is indicated, as one can see the waste tax in the municipality of Almere is more than 300 euro a year.

First of all, within the waste collection a distinction can be made between the separations of waste at household level. In some municipalities households have to separate their waste into different flows such as plastics, metal- and drink containers (PMD), biodegradable waste, paper, glass and residual waste. However, in other municipalities households are allowed to put most waste together. Secondly the collection of waste can be different; some municipalities collect the waste at the houses while others have special waste collection points where households can dispose their waste. Thirdly, municipalities have different waste taxes; these taxes can be static or dynamic systems. After disposal of the household waste, the waste gets collected and is stored until the waste facilities are ready to be processes it.

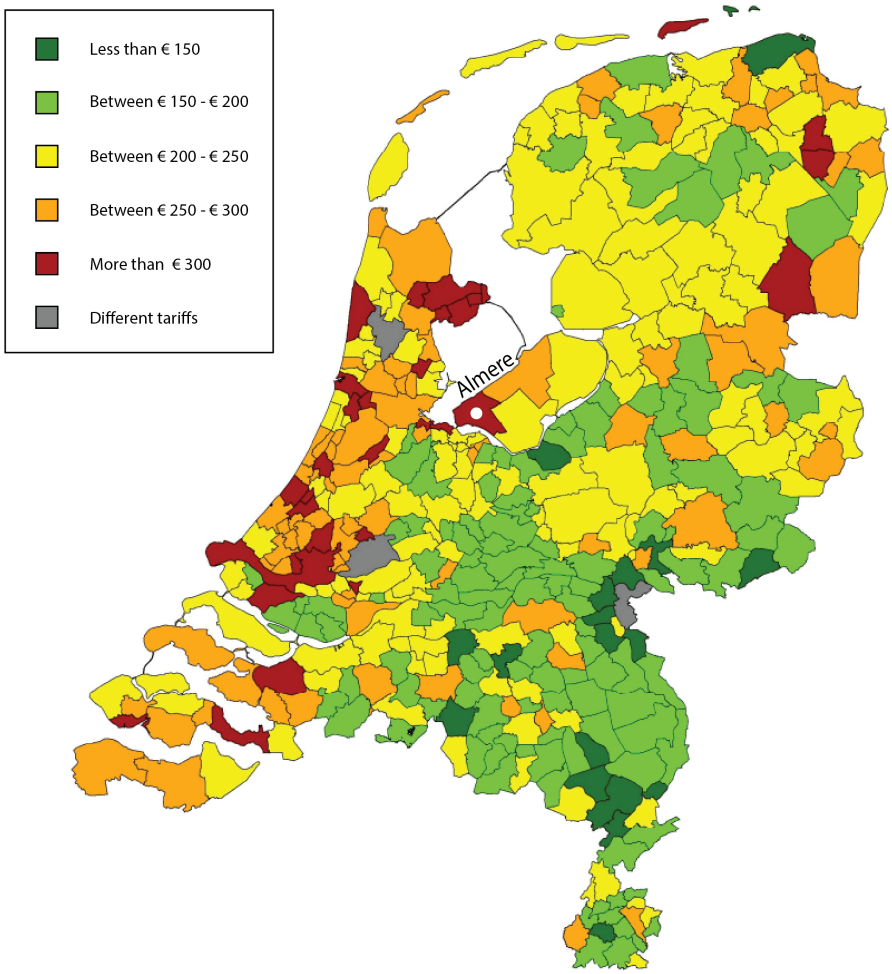


Figure 2.5. Household waste tax per municipality in the Netherlands in 2015 (Afvalfonds Verpakkingen, 2015)

### *Diftar*

'Diftar' stands for ***dif***ferentiated waste ***tar***iffs per household. In this waste system the quantity of waste each household deposits is registered and consequently has to pay for their waste tax. So when households separate their waste streams according the system they will end up with less residual waste and as a result pay less waste tax. There are different ways municipalities can implement diftar to know:

- Frequency: Here there is a fixed rate and a variable amount, which depends on how often the containers are emptied.
- Volume / Frequency: Here there is a fixed rate plus a variable rate on the amount of times containers are emptied together with the volume that is disposed.
- Weight: Here the rate consists of a fixed rate and a variable amount, based on the amount of waste disposed, weighted in kilos.

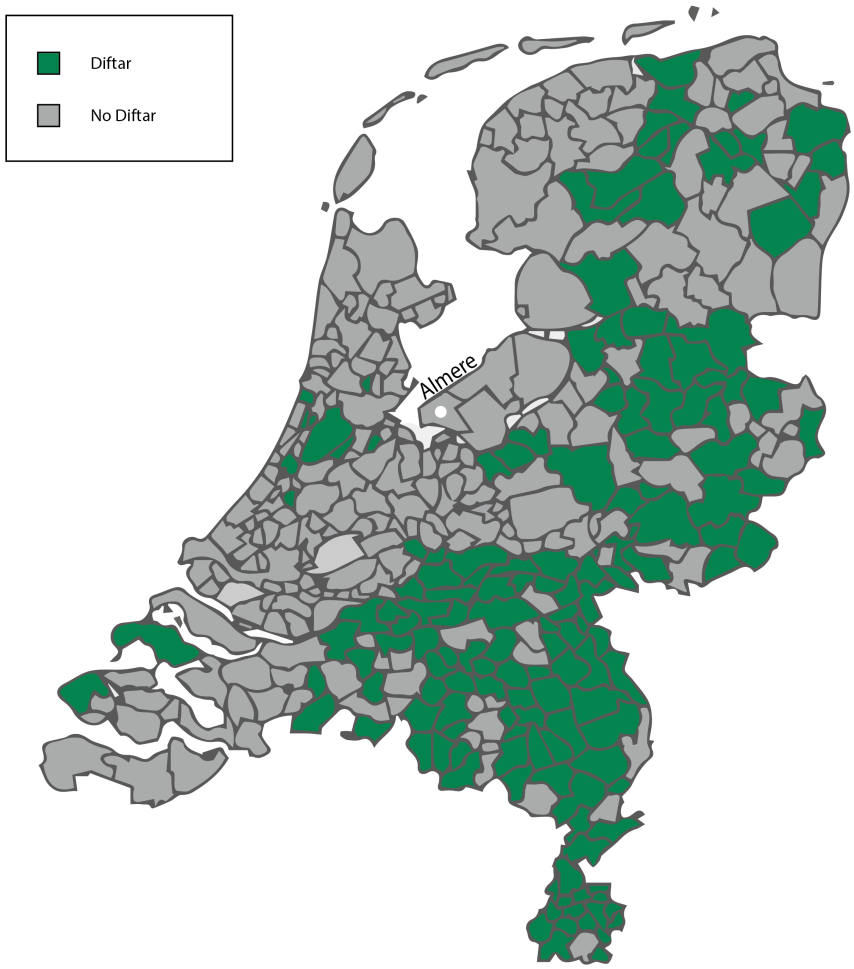


Figure 2.6. Municipalities classified according to their waste tax system (Afvalfonds Verpakkingen, 2015).

In figure 2.6 the municipalities that implemented diftar are shown in green and municipalities that do not have diftar are shown in grey.

### 2.1.7 Household plastic packaging

In figure 2.7 the plastics that are mostly used for packaging and make up most of the household plastics are shown. All household packaging plastics are thermoplastics.


Figure 2.7. Plastics sorted on resin identification code (RIN) in packaging applications (Ellen McArthur Foundation, 2016). RIN: 1: Polyethylene terephthalate (PET); 2: High-density polyethylene (HDPE); 3: Polyvinyl chloride (PVC); 4: Low-density polyethylene (LDPE); 5: Polypropylene (PP); 6: Expanded polystyrene (EPS)

### 2.1.8 Household plastic waste processors

In the Netherlands there exist only three waste processors that separate and sort plastic household packaging waste, to know: Omrin, Attero and SUEZ. The majority of the municipalities have contracts with SUEZ, which has a plastic sorting installation in Rotterdam. Attero also has sorting installations for plastics where they are able to separate the different kinds of plastics. Omrin has sorting installations where they separate plastics from the residual waste, so called post separation. These three processors are responsible for the processing of the plastic packaging waste from households in the Netherlands. They separate the waste in the following streams: PET, PE, PP, foils, and mixed plastics.

### 2.1.9 Plastics waste market

In the Netherlands, waste processors separate the household plastics and sometimes also process them into regranulate as Attero does. There is a demand for mono-plastics and the following companies are active in the Netherlands making flakes, regranulate or products from plastic waste:

Table 2.4. Companies active in the Dutch plastic regranulate market (NRK Recycling, 2016; RHDHV, 2018).

| | PVC | PP | LDPE | HDPE | PS | EPS | ABS | PET |
|---|---|---|---|---|---|---|---|---|
| 4 PET Recycling | | | | | | | | PET |
| Attero | | PP | LDPE | HDPE | | | | PET |
| Auf den Haar Kunststof Recycling | | PP | | HDPE | | | | |
| Broeckx Plastic Recycling | PVC | | | | | | | |
| BlueAlp | | PP | LDPE | HDPE | | | | PET |
| Caroda Polymer Recovery / Daly Plastics | PVC | PP | LDPE | HDPE | PS | EPS | ABS | PET |
| Community Plastics | | PP | LDPE | HDPE | PS | | | PET |
| Cumapol | | PP | LDPE | HDPE | | | | PET |
| Caroda Polymer Recovery | | PP | LDPE | | PS | | | |
| De Paauw Plastic Recycling | PVC | PP | LDPE | HDPE | PS | | ABS | PET |
| Hummel Recycling | | PP | LDPE | HDPE | | | | |
| Ioniqa | | | | | | | | PET |
| Inverko Polymers | | PP | | HDPE | PS | | ABS | PET |
| Kras Recycling | | PP | LDPE | HDPE | | EPS | | |
| Lankhorst plastic producten | | PP | LDPE | HDPE | | | | |
| Morssinkhof Rymoplast | | PP | LDPE | HDPE | PS | | | PET |
| Ovimo Plastics | | PP | LDPE | HDPE | PS | | | |
| PHB, Plastic Herverwerking Brakel | | PP | | HDPE | PS | | ABS | |
| Plasticiet | | | LDPE | HDPE | PS | | ABS | |
| Polystyreneloop | | | | | PS | | | |
| Poredo | | | | | | EPS | | |
| QCP | | PP | LDPE | HDPE | | | | |
| Refil | | | | | | | ABS | PET |
| Reflow | | | LDPE | HDPE | | | | PET |
| Rodepa Plastics | | PP | LDPE | HDPE | PS | | | |
| Thans Plastics | | PP | | HDPE | | EPS | | |
| Van der Vleuten Kunststofindustrie | | PP | | | PS | | | |
| Van Werven Plastic Recycling | PVC | PP | LDPE | HDPE | PS | | ABS | |
| Veolia Polymers | | PP | | | | | | |
| Virol / WPT | | | LDPE | HDPE | | | | PET |

There are is a limited amount of companies that are active in the processing of plastic waste into regranulate. Most of these companies are specialized in PP, PE, PS and PET. Some of them are also able to process PVC, EPS and ABS. However, these processors only work with mono-streams and do not work with streams of mixed plastics.

### 2.1.10 Mixed plastic waste market

The processing of the stream of mixed plastics, that becomes available after the separation of all plastics, is mostly done by companies abroad of which most of them are in Germany. However, there are some companies in the Netherlands that can or are planning to recycle these mixed plastics into products. Companies that are active in the Dutch mixed plastic market are the following:

Table. 2.5. Companies active in the Dutch mixed plastics market (NRK Recycling, 2016; RHDHV, 2018).

| Company | Location |
|---|---|
| InGarden | Zeewolde |
| Pryme | Rotterdam |

| | |
|---|---|
| BlueAlp | Eindhoven |
| Recycled Park | Rotterdam |
| Save Plastics | Ulft |
| ER Plastics | Sittard |
| Upp! UpCycling Plastic | Zuidermeer |

### 2.1.11 Summary

The CE is a new concept away from the linear economy where sales revenues are decoupled from material input by using a restorative IE by intention and design.
There exist two kinds of recycling: mechanical recycling and chemical recycling. Mechanical recycling is already happening and chemical recycling is in development.
There are several directives regarding the recycling of waste in the EU binding for her member states. These directives are regarding the management of packaging and packaging waste, reduction of waste generation and use of resources.
In the Netherlands there is the Packaging covenant, which is an agreement between the Dutch government and packaging industry. This covenant is about the collection, processing and consequently marketing of processed household waste, which includes plastic household waste. Because it is a covenant it is not legally binding. Recycling Netwerk has evaluated the covenant and came to the conclusion the Dutch government should terminate the covenant and take control over the required standards for recycling. The packaging covenant is insufficiently workable, not binding and has by no means achieved its intended goal. Clear rules and standards are needed regarding the design of products and packaging. The producer responsibility needs to be concrete.
To receive compensation for the collected household plastics, a minimum of 45 percent needs to consist of mono plastics such as PET, PE, PP, EPS and foils. Mono streams of plastics have a market value and can be sold. But to be able to receive a reimbursement as municipality the mono streams of plastics need to be processed to a certain standard, the DKR standard, which is determined for each of the plastic streams. The mixed plastics stream is considered valueless at the moment. These mixed plastics are mostly recycled in Germany. Reimbursements for the collection, processing and marketing of household waste plastics are getting less each year.
Municipalities are free to manage their own waste management and different waste systems exist. There are three plastic household waste processors in the Netherlands: Omrin, Attero and SUEZ. There are more companies that work with the processed mono streams. For the mixed plastic waste waste there are less companies active in the Netherlands, seven companies have been found that are active in this niche market.

## 2.2 Theoretical review

### 2.2.1 Strategic niche management

The notion of a ‘niche’ has been apparent in innovation literature but the role they can play as a driving force in sustainable development has not (Schot and Geels, 2008). Different evolutional economists (Saviotti, 1996; Windrum and Birchenhall, 1998; Frenken, Saviotti and Timmetter, 1999) and management scholars (Astley, 1985; Lynn, Morone and Paulson, 1996) have underlined the importance niches can play in radical innovations in markets. Levinthal (1998) takes the existence of market niches for granted and made the assumption that niches are actually experimenting with the dominant technologies in the market. New technologies can have difficult times as they have to compete against existing and dominant technologies on the market. There isn’t necessarily a lack of new technologies, but the technologies have to bridge the well-known ‘valley of death’ between their research and development (R&D) phase and their market introduction (Schot and Geels, 2008).

To address this problem Kemp, Schot and Hogema (1998) presented the Strategic Niche Management (SNM).

SNM is characterized by the assumption that modifying technological innovative niches can facilitate in sustainable trajectories. Examples of technological niches are protected areas that offer space for nurturing and experimentation with technology, user practices, and regulatory structures. In SNM, scholars reason that sustainable development needs interconnected social and technological change; radical innovations don't come from technological change alone but instead from both technological and social change. SNM is developed to assist in the management of: (1) socially preferred innovations such as sustainability; (2) radical innovations that mismatch the existing infrastructure, user practices and regulations. SNM is not primarily developed as a policy tool but as a model to determine the processes that determine successful niche development. As a model it is useful to analyze on-going dynamics such as the developments and interactions taking place within the niche. It is a good model to use in a practical way, not from top-down but from bottom-up. The bottom-up progress in a niche can come from a broad range of actors including companies, users and societal groups. Governments cannot create niches; instead niches emerge from a combination of social and technical collective enactment. However, the (future) course of niches can be influenced into a direction, in the case of Almere into a more sustainable direction (Schot and Geels, 2008).

### *Internal niche processes*

In earlier SNM research the idea is that selective introduction of new sustainable technologies, through a process of niche management, to the market can lead to the change and/or replacement of the dominant technologies. Replacement would take place through the development of a new socio-technical regime that embeds the rules (standards, skills, design, and regulations) for the ways to produce, use and regulate the new technology. This is a bottom-up process where technological innovations arise in niches, consequently turn into market niches, and eventually replace or change the existing regime (Schot and Geels, 2008).

In a broad range of researches (Elzen, Hoogma, and Schot et al., 1996; Kemp, Schot, and Hoogma, 1998; Hoogma et al., 2002; Grin and Van de Graaf, 1996), three internal processes that are essential for the development of a technological niche, are distinguished:

1) *Expectations and visions*. These are crucial for the development of a niche while they provide direction to learning processes, attract attention and serve as legitimation for protection and nurturing. Expectations can contribute to successful development of a niche when they are: (a) more robust (shared by multiple actors), (b) more specific (expectations have to give guidance), and (c) qualitatively high (content of expectations is validated by continuing projects);
2) *Social networks*. Social networks are important in the creation of legitimation for a new technology, enable interaction between stakeholders and provide in the required resources (money, people, expertise). Social networks are of a greater value to the development of a niche when: (a) the networks are broad (involvements of relative outsiders to the niche can broaden cognitive frames), and (b) when the networks are deep (actors representing their organizations should be able to organize commitment and resources in their own organizations and networks);
3) *Learning*. Learning processes contribute to development of a niche when they are not only focused on the accumulation of data (first order learning) but are also focused on change in cognitive frames and assumptions (second order learning). Learning processes exist at multiple levels:
    a. Technical aspects and design specifications
    b. Market and user preferences
    c. Cultural and symbolic meaning

d. Infrastructure and maintenance networks
e. Industry and production networks
f. Regulations and government policy
g. Societal and environmental effects.

However, Smith and Raven (2012) emphasize three other processes within the development of a technological niche:

1) *Shielding*. Radical innovations tend to come to existence in niches that shield these innovations from mainstream selection pressures found in the dominant regime. These pressures are found in the market but are also on the actors in the niche to choose the correct radical innovation. The correct selection is mainly based on how well the niche can be integrated into the dominant regime. Shielding can be passive or active. Passive shielding is defined as: "generic spaces that pre-exist deliberate mobilization by advocates of specific innovations, who exploit the shielding opportunities they provide" (Smith and Raven, 2012). Active shielding is defined as: "spaces that are the result of deliberate and strategic creation by advocates of specific path-breaking innovations to shield regime selection pressures" (Smith and Raven, 2012). Shielding has different purposes, to shield innovations for their inability to compete, lack of infrastructure and/or incompatible guiding in the current regime.
2) *Nurturing*. After radical innovations are shielded appropriately opportunities arise to nurture these innovations. 'Nurturing' is defined as "processes that support the development of a radical innovation" (Smith and Raven, 2012). In the SNM the most important nurturing processes are the articulation of expectations and visions, helping social network processes , and to support learning.
3) *Empowering*. Along the way the radical niche innovations are nurtured into competitive innovations within the dominant regime and consequently do not need their shielding anymore. When a radical niche innovation is competitive in the dominant regime within unchanged selection environments, this is labeled as 'fit and conform empowerment', the first stage of empowering. But competitiveness is not a guarantee for success. When the niche innovation is institutionalized within the dominant regime some of its features such as norms and routines are also institutionalized in the transformed regime. The niche is now empowered by its ability to change the regime, this is the second stage of empowering labeled as 'stretch and transform empowerment'. This latter process of empowerment is not only dependent on the niche but also relies upon other processes of change within the regime, society and economy. Sustainability advocates can empower the institutionalization of environmental values and this way empower sustainable niche innovations (Smith and Raven, 2012).

Schot and Geels (2008) see SNM as an useful management tool that takes the dynamic force of market competition as building and leverage point to overcome a lock-in of the niche and stimulate socio-technical diversity. Pilots in 'showcase projects' are of importance because it is the implementation and specification of visions and expectations that contribute most to developments of a niche (Schot and Geels, 2008). Hendry, Harborne and Brown (2007) note that visioning before a pilot can help in the expansion of networks and learning processes. However, there are always powers that can impede the development of technologies; technology actors tend to exclude specific actors and primarily focus on the technical aspects while neglecting the social aspects (Schot and Geels, 2008).

Many SNM studies explored the failures and successes of niches on their development from a technological niche towards a market niche and eventually to a regime shift (Schot and Geels, 2008).

But within the developments of a niche, Raven (2005) and Van Mierlo (2002) point out that a distinction should be made between local socio-technical projects and the niche level. That is because development of niches can happen at two levels simultaneously: (a) the level of local-technical projects and (b) the niche level. The level of local-technical projects (a) can be subscribed as developments that start with one or more projects executed by local networks of actors that are innovative because of personal or local reasoning. The cognitive rules (expectations, visions) that lead these projects are mostly diffuse, broad and unsteady. When learning processes in these local processes are compared and combined this can lead to the increase of more articulated, specific and stable cognitive rules on the niche level. On the niche level (b) a niche can be characterized as an evolving community sharing a set of cognitive, formal and normative rules. In this conceptualization a niche is not only featured by protection but also by the locality and stability of rules and networks (Van Mierlo, 2002; Deuten, 2003; Raven, 2005; Geels and Raven, 2006).

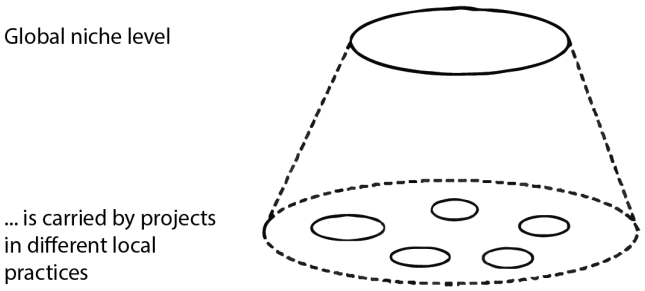


Figure 2.9. The niche level and local technical projects (Geels and Raven, 2006, p. 378).

This concept has moved the focus from single niche projects and their success or failure to sequences of projects. These sequences can aggregate into learning trajectories. This way learning from failures also become of value and can contribute to the success of other projects (Schot and Geels, 2008).. External conditions, such as the price of oil and liberalization, can also have impact on the adoption and direction of developments (Geels and Raven, 2006). Diversity is good for the development of a niche because it stimulates learning and the development of networks (Schot and Geels, 2008). In figure 2.10 an overview of an emerging technical trajectory performed by local projects is presented.

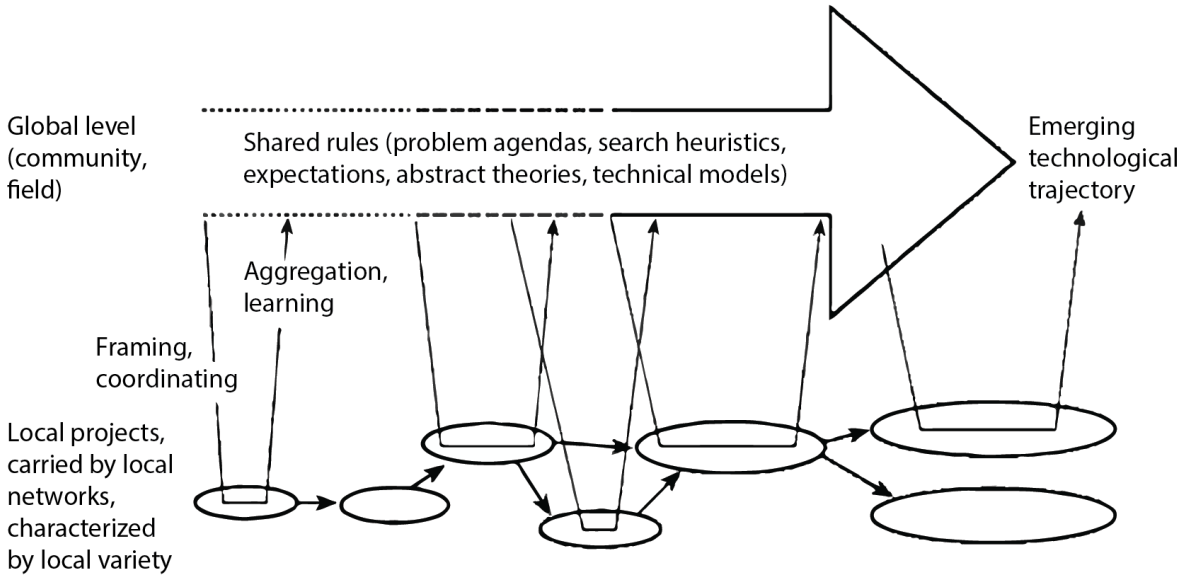


Figure 2.10. Emerging technical trajectory carried out by local projects (Geels and Raven, 2006, p. 379).

SNM is a good model to analyze important processes and interactions that take place within the development of a niche. However, internal niche developments are not solely responsible for the developments of a niche; external factors do also play a significant role. Without the help or pressure of a broader set of forces and processes niche innovations are hardly ever able to survive and set a regime change in motion. To link internal and external factors, Schot and Geels (2008) took the SNM into the multi-level perspective (MLP). The MLP will be explained further in the following section.

### 2.2.2 Multi-level perspective

Rip and Kemp (1998) introduced the multi-level perspective (MLP). In the MLP three analytical levels are distinguished: (1) the micro-level where niches are and where radical innovation arise, (2) the meso-level that is shaped by the socio-technical regime and (3) the macro-level that is shaped by the socio technical landscape.

The socio-technical regime can be defined as a group where development takes place along technological trajectories with shared cognitive routines, belief systems, and regulative and normative rules. Actors that contribute to technological developments in the regime range from engineers, scientists, policy makers, users, to special interest groups (Nelson and Winter, 1982; Bijker, 1995; Geels, 2002; Schot and Geels, 2008).

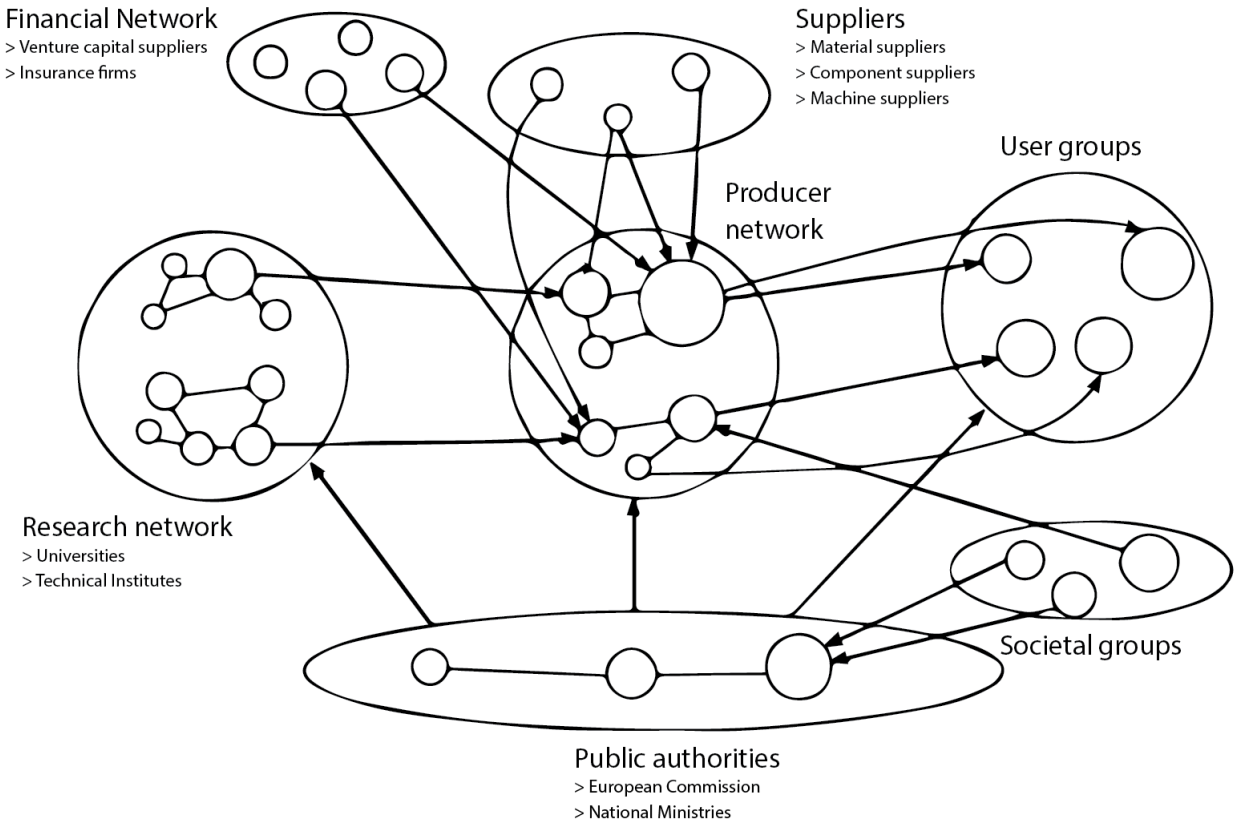


Figure 2.11. The multi-actor network in socio-technical regimes (Geels, 2002, p. 1260).

The socio-technical landscape can be defined as an external environment that lies beyond the direct influence of the actors in niches and regimes. Changes in the socio-technical landscape are slow and are influenced by things such as macro-economics, deep cultural patterns and macro-political developments (Schot and Geels, 2008; Geels and Schot, 2007).

MLP recognizes that innovations on the niche level are important. However, niches can only successfully shift regimes when they go together with changes at the regime and the landscape level (Schot and Geels, 2008). Shove and Walker (2007) describe this process of change as “processes of co-evolution and mutual adaption within and between layers”. Therefore niche innovations do not always have to compete with each other for the dominant regime, they can also integrate in the current regime and change the regime from within. So a niche can grow and constitute a new regime by replacing the dominant regime but it can also integrate in existing regimes and change from within. In this view the dynamics are actually less about technological innovation within a niche and more about the way a niche diversifies, piles up, and add to changes in behavior, practices and routines of the regime actors (Schot and Geels, 2008).

Schot and Geels (2008) distinguish six different dimensions that can constitute a social-technical regime, to know: technology, markets and user preferences, science, culture, policy, and industry. In figure 2.12 different the three different levels (socio-technical landscape, socio-technical regime, niche-innovations) are connected to each other, but they also have their own dynamics. On the landscape level changes are slow (e.g. macro-economics, deep cultural patterns, macro-political developments) and are represented with the bold long arrows. These changes can put pressure on the regime. At the regime level the dynamics between the different actors can result in ‘tensions’, showed as short arrows and representing uncertainty and differences in opinions. At the niche level there are multiple actors working on radical innovations; the small arrows represent the different directions of the innovations, there’s not one direction as there is no dominant design yet. These different directions are shown as the small arrows. The main belief in the MLP is that transitions are set in motion through transactions between processes at different levels: (a) niche innovations create internal momentum, (b) the landscape changes and puts pressures on the current regime, (c) weakening of the regime creates areas of opportunities for niche innovations (Schot and Geels, 2008; Geels, 2002).

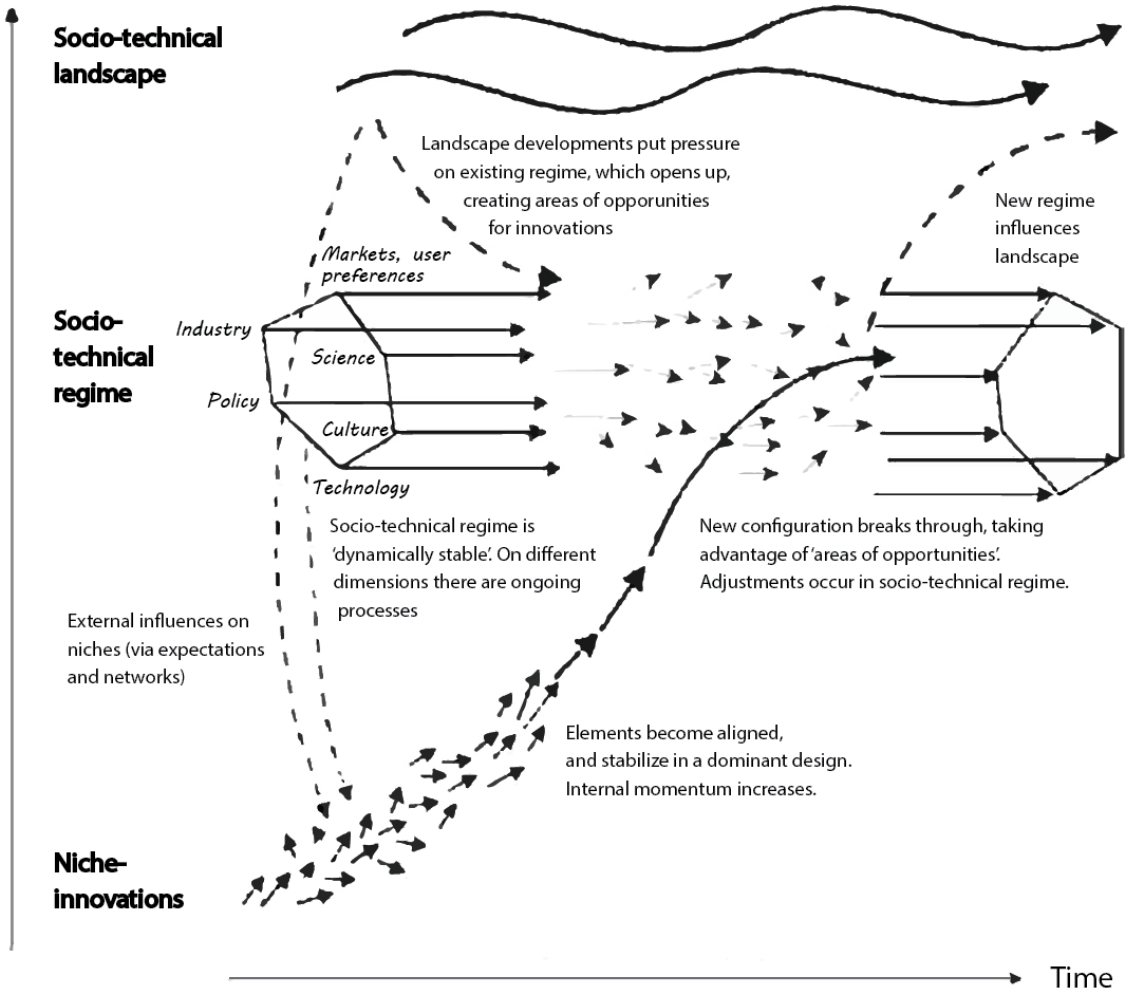


Figure 2.12. Multi-level perspective on transitions (Geels, 2002, p. 1263 ).

### 2.2.3 Business model innovation

Bidmon and Knab (2014) used the MLP to show the possible role business models can play in socio-technical transitions. The roles business models can play will be reviewed in this section. The SNM does focus on single niche actors but does not involve the role the business models of the involved actors can play. The MLP is a model that overarches transition processes but does not focus on the behavior of single actors. It does however explicitly allow zooming in on single actors such as companies. Therefore the MLP framework lends itself good to analyze the role of companies and their business models in a transition (Bidmon and Knab, 2014).

There is a broad range of definitions of a business model but there is consensus that at the most basic level a business model is a description of the way companies create and capture value (Bidmon and Knab, 2014; Baden-Fuller and Haefliger, 2013; Habtay, 2012). A business model couples the companies input resources and market performances and allows companies to turn technical success into commercial success (Zott, Amit, and Massa, 2011; Teece, 2010; Chesbrough, 2010). This research will use the following definition of Bidmon and Knab (2014): “the business model describes how a company creates and captures value in a value network, which transcends the boundaries of the focal company. It is both, a market device to commercialize innovative technology and subject to innovation”.

The business model describes how a company does its business. Bocken et al. (2014) divided the business model into three main elements: the value proposition, value creation and delivery and

value capture. The value proposition is about the value of the product and capturing of the ecological and social value together with the economic value. The value creation is the heart of the business model and is all about finding new business opportunities and markets. Value capture is about how the company is going to capture value through the delivery of products, services or information. The concept of this business model framework is shown in figure 2.13.


Figure 2.13. Business model framework (Bocken et al., 2014, p. 43).

Business model innovation (BMI) is a redefinition of the ways in which a company creates and captures value. The business model can thereby be seen as the current business model of a company or the business model that dominates in an industry. It is interesting to analyze the role business models and consequently the innovation of business models play in the socio-technical system and transitions in the system (Schneider and Spieth, 2013; Bidmon and Knab, 2014). Bocken et al. (2014) developed three main types of BMI: technological, social and organizational. Within this grouping several models per grouping are defined. The technological type of business innovation encompasses models where a technical innovation component, such as the manufacturing process, reuse of materials, and use of renewables, is dominant. Social models are mainly focused on social innovation such as protection of biodiversity, transparency about environmental impacts and slow fashion. The organizational models are targeted at values with a repurpose for society and scale up solutions such as alternative ownership and collaborative approaches. Figure 2.14 gives an overview of the sustainable business model archetypes Bocken et al. (2014) designed.

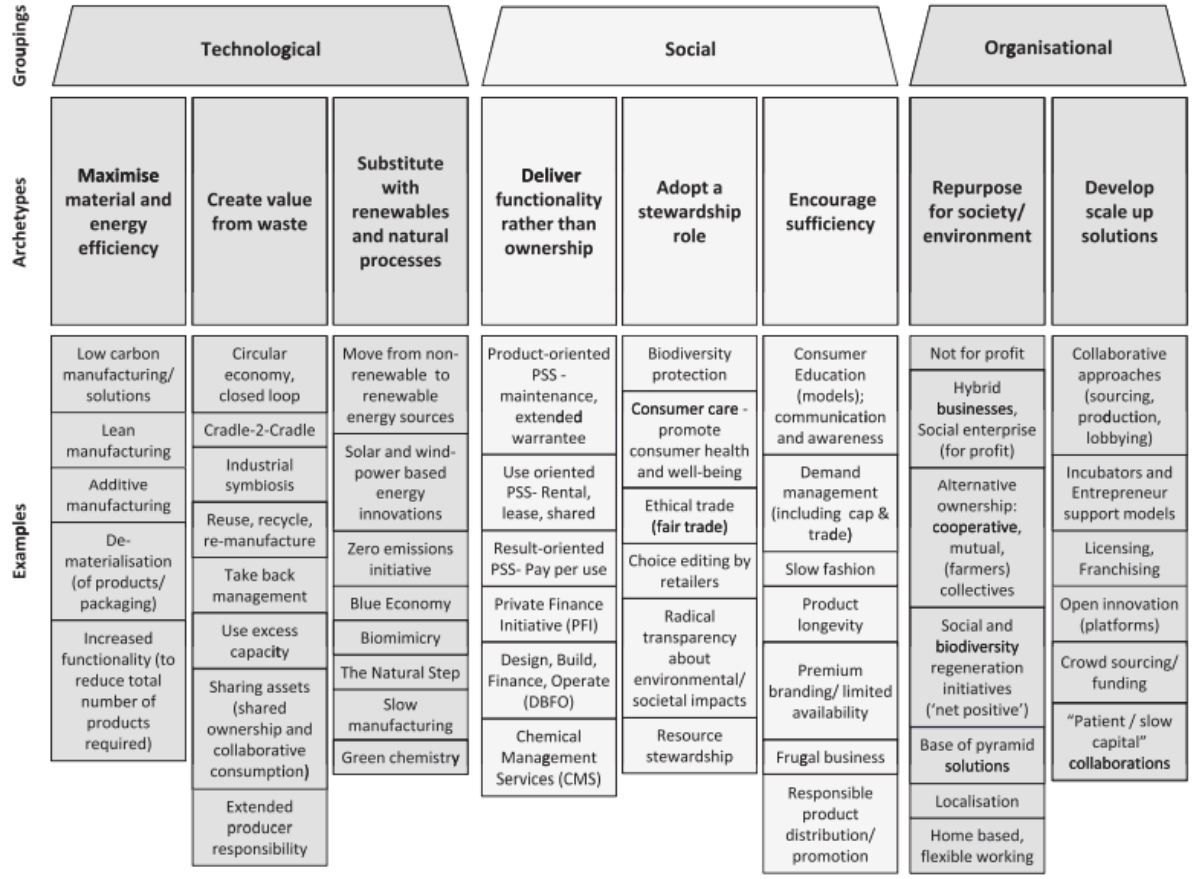


Figure 2.14. Sustainable business model archetypes (Bocken et al., 2014, p. 48).

Bidmon and Knab (2014) made a distinction between the roles business models can play in socio-technical transitions. Business models can play the following three roles:

*1 - Business model as a device to commercialize technological niche innovation*
Within a socio-technical system the key role of a business model is to commercialize innovative technologies developed at the niche level. This way the business model has the potential to connect company and system level. A business model belongs to a company but spans the boundaries of this company (Zottt and Amit, 2010). This way the business model connects technological innovation to elements and actors that are outside of the company; these elements and actors can be seen as parts of the socio-technical regime. The business model commercializes the technology and they are fundamentally linked but completely different concepts (Baden-Fuller and Haefliger, 2013). As the business model describes how business is done among different actors it represents inherent and implicit rules between these actors. Bidmon and Knab (2014) argue that in the MLP the business model therefore has a higher degree in the structuration of local activities than technology as shown in figure 2.15.

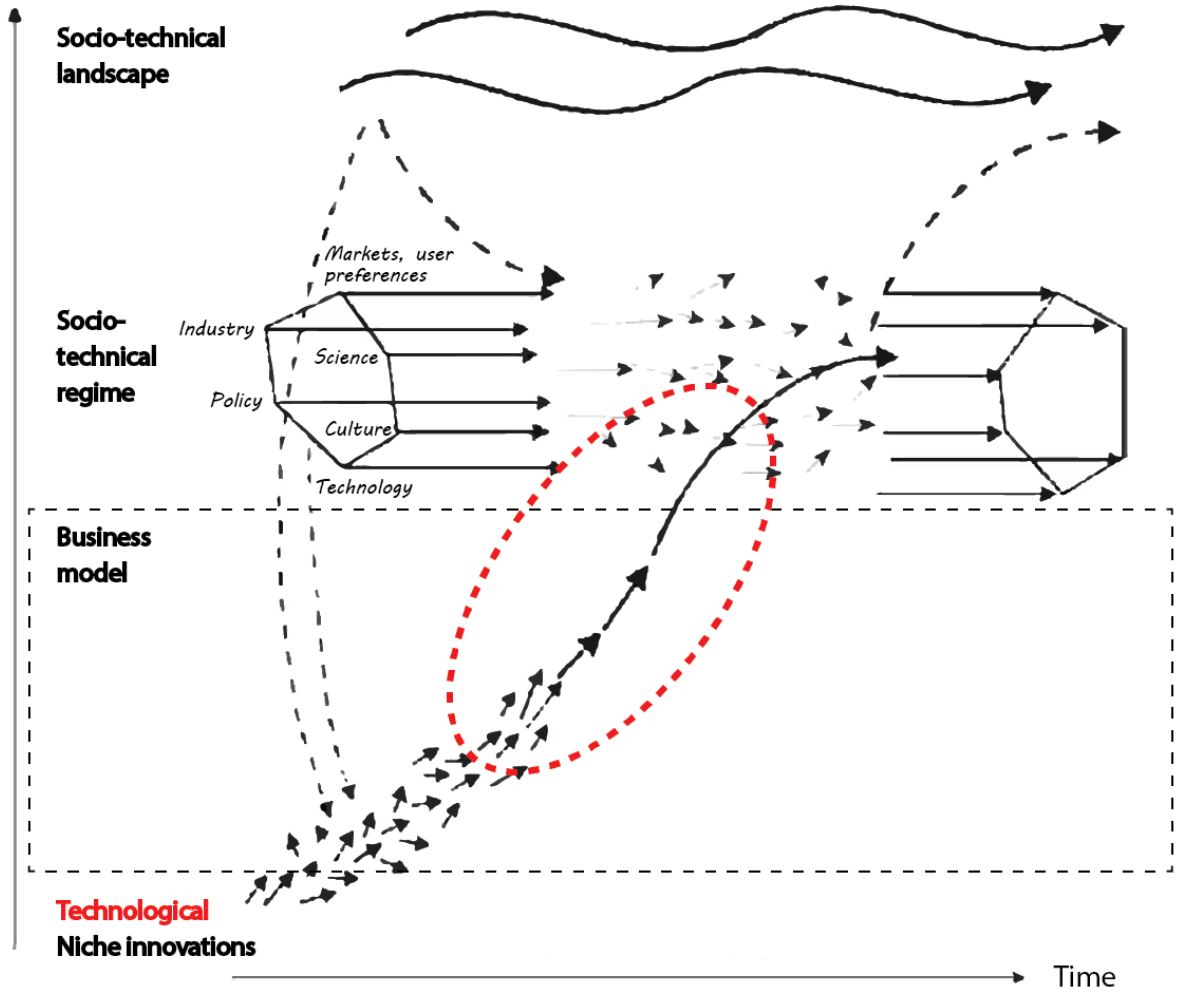


Figure 2.15. The business model as a device to commercialize technological innovation (Bidmon and Knab, 2014, p. 5).

*2 - Business model as part of the current socio-technical regime*

A viable business model is a business model that allows all the actors in a value network to create and capture value (Bidmon and Knab, 2014). Business models of new companies preferably have to fit the established value chains and consequently the customer and supplier expectations. This way the established actors are able to recognize the opportunities for value creation (Sabatier et al., 2012). A new technology that encompasses a business model and also fits in the current socio-technical regime will be able to free-ride on the existing infrastructure (Haxeline et al., 2008). Taking this into account, a company might be more successful to achieve their technological innovation by using a business model that is consistent within the current regime. However, it is not likely that this approach will be the best to radically change the way business is done (Bidmon and Knab, 2014).

Sabatier et al. (2012) define the dominant business model logic as: "the generic scheme of value creation and capture shared by actors in an industry". The business model logic is an integral part of a socio-technical regime and is aligned to other elements such as regulation and user preferences. The innovation of business models can in this way be understood as the re-conceptualization of the dominant business model logic, in a socio-technical regime (Bidmon and Knab, 2014).

*3 - Business model as non-technological niche innovation*

When framing innovative business models as niche innovations and the dominant business model logic as the socio-technical regime, they can evolve parallel to the process the MLP describes for

technological niche innovation. First they emerge in niches, where small networks of actors are experimenting with different models and go through a learning process until a dominant new business model design emerges. The current regime is stable and the chance for the new business models to break through are only when opportunities arise, these opportunities can lead to adjustments in the socio-technical regime and in time replace the current business model logic (Bidmon and Knab, 2014).

BMI calls for a redefinition of transactions among various actors within the value network (Zot and Amit, 2010). Interaction between BMI that is developed in the niche and the dominant business model at the socio-technical regime level is represented in figure 2.16. As shown in the figure, the development of the business model takes one level above the technological innovation. Bidmon and Knab (2014) made a distinction between BMI and technological niche innovation. In the MLP external influences, represented with the long vertical dotted arrows from landscape or regime level to the level of the niche are translated to the business model niche in the shape of factors that have been found to drive BMI, such as customer demands or new regulation (Wirtz, 2011). Additionally, technological niche innovation can influence the development of new business models, represented by the small pink arrows from the technological niche level to the business model level in figure 2.16.

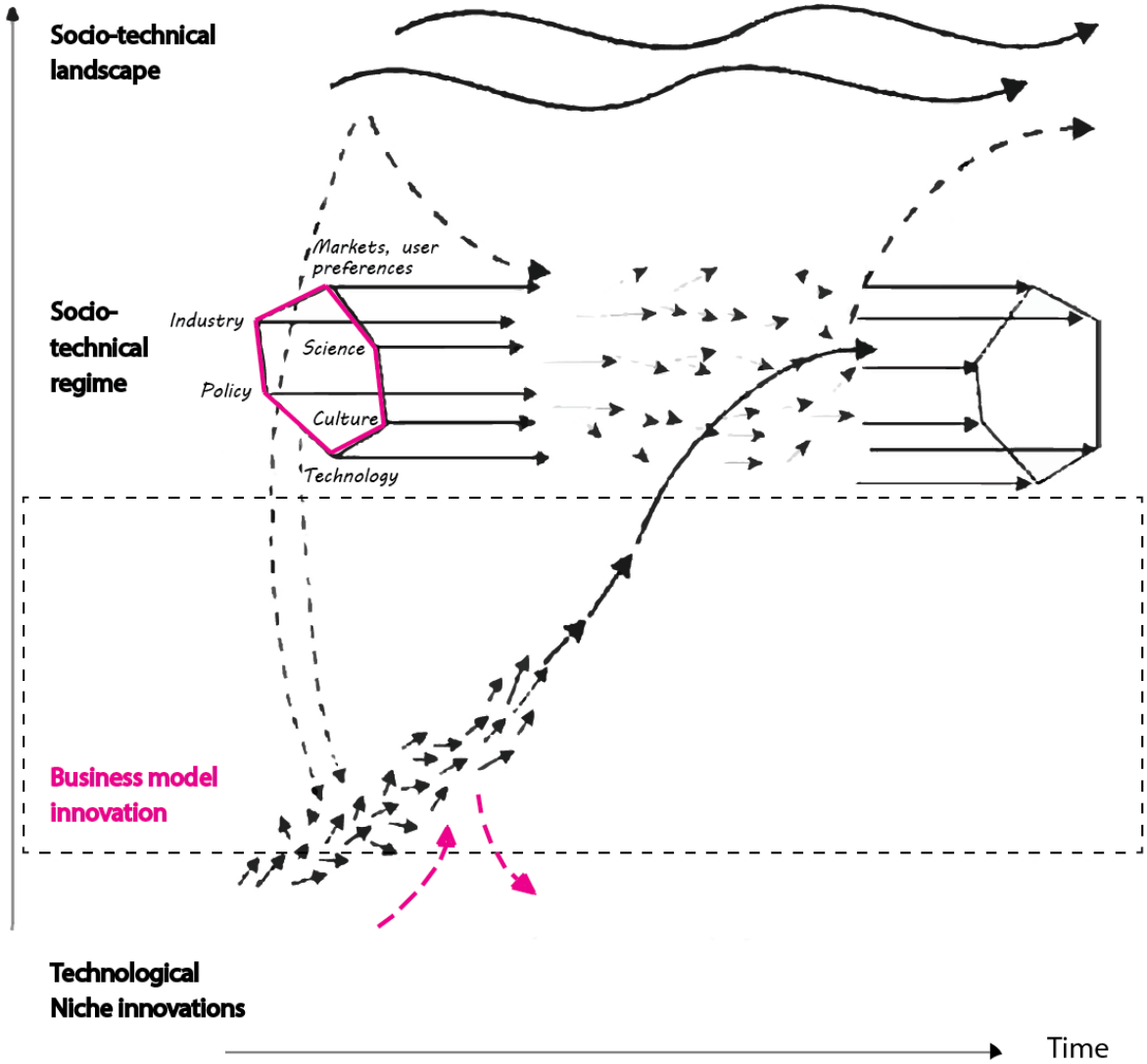


Figure 2.16. Business model as non-technological niche innovation (Bidmon and Knab, 2014, p. 8).

Bidmon and Knab (2014) state that it is specifically the systemic nature of business models that can turn them into key assets to effect transitions, especially when more powerful incumbent actors join the niche. In this way business models of smaller firms merge with the business models of larger incumbent firms, leading to spill-over on the main-stream market. It is thereby important to take into account that the regime and landscape level do not only throw up barriers for niche actors but instead that developments on these levels may also get more powerful actors to have interest in new business models (Elzen et al. 2004).

### 2.2.4 Summary and conclusions

#### *Summary*

To analyze socio-technical transitions the MLP provides a framework and distinguishes three analytical levels: niche, regime and landscape. MLP recognizes that innovations on the niche level are important but also points out niches can only successfully shift socio-technical regimes when they go together with changes on all three levels. The key idea here is that change takes place through processes of co-evolution and mutual adoption within and between the different levels. This research will analyze the developments, that are of influence on the recycling of household plastics, on the landscape, regime and niche level.

SNM is an approach characterized by the assumption that sustainable trajectories can be facilitated by the modulation of technological niches. As new technologies have to compete to existing technologies they can develop best in an area that allows for nurturing and experimentation with technology, user-practices and regulatory structures. Development is not only dependent on technological change but also on social change. Within the development of a niche technology the niche mostly has to replace an existing dominant technology, which is embedded in a socio-technical regime that has its own rules. The idea of SNM is a bottom-up process where niche innovations arise, turn into market niches and eventually change or replace the existing regime. For the successful development of a technological niche three internal niche processes are essential for the actors: (1) articulation of expectations and visions; (2) building of social networks; (3) learning processes. In this research developments in the niche of MPHW will be analyzed in Almere. Here the niche level is carried by the companies active in the MPHW value chain and the municipality of Almere. These companies and Almere have their own visions, ideas, and cognitive rules. As learning processes of multiple local projects, such as the one in Almere, are combined, this can lead to more articulated, specific and stable cognitive rules on the niche level. To make a niche, such as Almere wants to realize, reach to success in the market it is important to: (1) shield, (2) nurture and (3) empower it.

The role business models can play are important for this research. The value proposition, value capture and value creation of the companies in the MPHW niche will be determined. Bidmon and Knab (2014) found three generic roles of business model innovation (BMI) in socio-technical transitions. Business models can be framed as (1) commercial devices promoting and distributing technological innovations within a socio-technical system, (2) the dominant business model logic that is present in the current socio-technical regime, (3) radical niche innovation with potential to alter the dominant business model logic, this offers a higher point of influence to effect systematic changes towards transitions than technological innovations. These different roles business models can play are of interest for change in the plastics household waste value chain. The business models leave room for more detailed insights on the role companies play and the dynamics behind this transition.

#### *Conclusions*

MLP, SNM and BMI are used to analyze the developments taking place in the plastic household waste value chain. Macro-economic and -politic pressures from the EU on their member states and the according successions of the Dutch government are part of the socio-technical landscape. The socio-

technical regime consists of all actors involved within the processing of household plastic waste. Those actors are the Dutch government, waste processors (SUEZ, Attero and Omrin), institutions involved within the processing such as the Wastefund Packaging, Nedvang, the Institute for Sustainable Packaging, and provinces and municipalities in the Netherlands. In this research the niche level exists of the companies that want to business within the field of MPHW, and actors as the municipality of Almere, Almere Resource Collective (GCA), Nedvang, and the Vijfhoek. Almere wants to create an area, in the Vijfhoek, where space is available for companies to experiment. There have been on-going interactions between the municipality of Almere, companies (MEPPP, InGarden, BlueAlp, Save Plastics, Upp! UpCycling Plastics), Nedvang and other external actors regarding a local plastic household waste value chain. In the case of Almere the social and technological changes are analyzed to see what are the drivers to locally recycle their household plastics. On the micro-level, the Vijfhoek in Almere is a space the municipality offers where the companies, that see opportunities in the local recycling of plastics, can experiment. The (1) expectations and visions, (2) social networks, (3) and learning from the companies are used to analyze the developments of the MPHW niche in Almere. The companies subject to this research could be of importance setting the sustainable transition of the overall plastic waste value chain in motion. Moreover, their business models will be analyzed and their role in BMI determined. The processes of (1) shielding, (2) nurturing, (3) and empowering, will be used to analyze the role the companies and the municipality of Almere can play in the development of the local plastic waste value chain.

# 3. Research design

## 3.1 Conceptual framework

The developments in the landscape and regime level will be analyzed through the MLP in chapter 4. Chapter 5 will analyze the niche of MPHW in Almere; BMI and SNM will be used to analyze the developments within this niche. The framework used in this research is pictured in figure 3.1. The landscape level is on top, it consists of factors such as economic pressures, cultural beliefs, social trends and environmental matters which take place on EU level and on national level in the Netherlands.

The next level is the regime level. This plastic household waste regime consists of actors such as the Dutch government, SUEZ, Attero, Omrin, Nedvang, Waste Fund Packaging and the Dutch municipalities. These actors follow a set of rules, the recognized practices in the the regime which are shaped by different dimensions identified in a regime: culture, policy, science, market and/or industry.

Below the regime level there is the niche level, this is the place where radical innovations occur. At the niche level are the municipalities such as Almere that want to recycle their waste locally and there are companies that make products from MPHW. The niche is characterized by BMI and technological innovation. BMI is how companies that are present in the niche shape their business models: their value proposition, value creation and delivery, and value capture. Business models can influence niche innovations and practices in the regime. With SNM the niche and its technological innovation is understood as the network, expectations and learning of the actors in the niche. A niche such as the municipality of Almere wants to create can act as 'protection' for new technologies to develop, mostly free from pressures present at the regime level. In this research the niche exists of the municipality of Almere and then the companies that are active in the niche such as Upp! UpCycle Plastics, BlueAlp, Save Plastics, InGarden, MEPPP, Recycling Avenue, and Polytential.

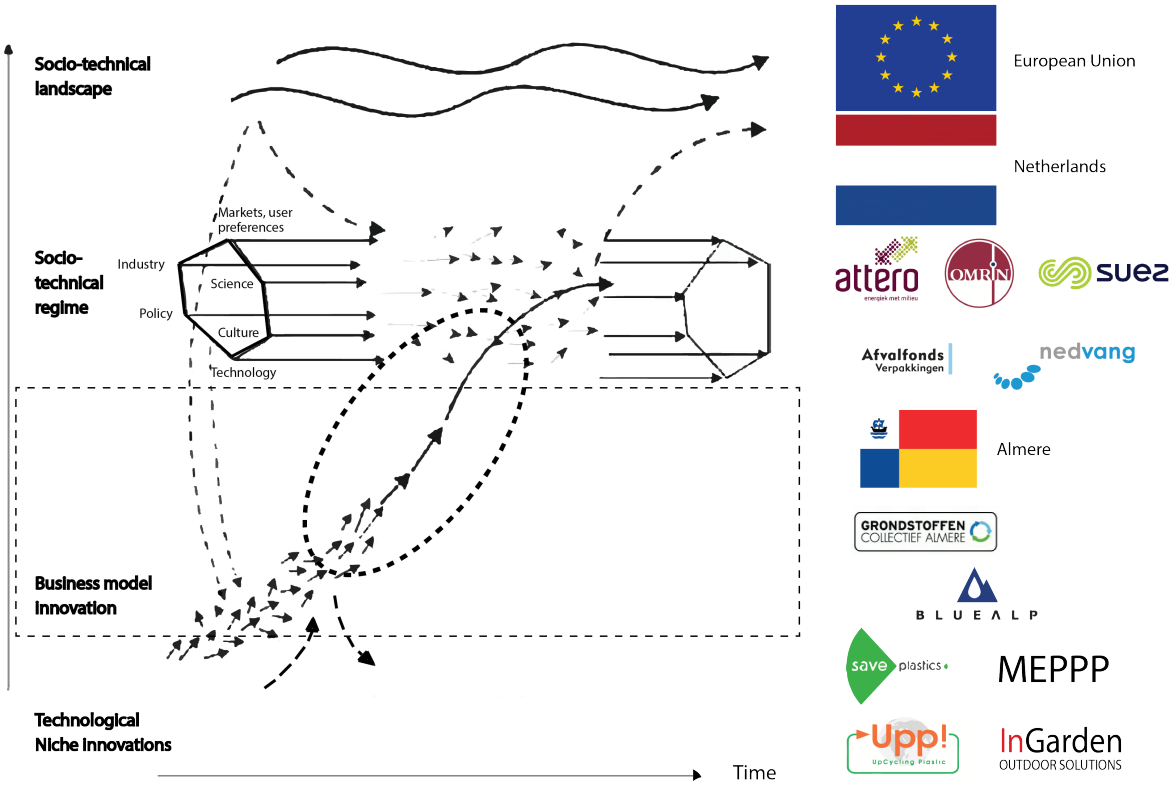


Figure 3.1. Conceptual framework adapted to the different levels in the plastic waste value chain.

An overview of the research and the different sections that are part of this research are presented in figure 3.2.

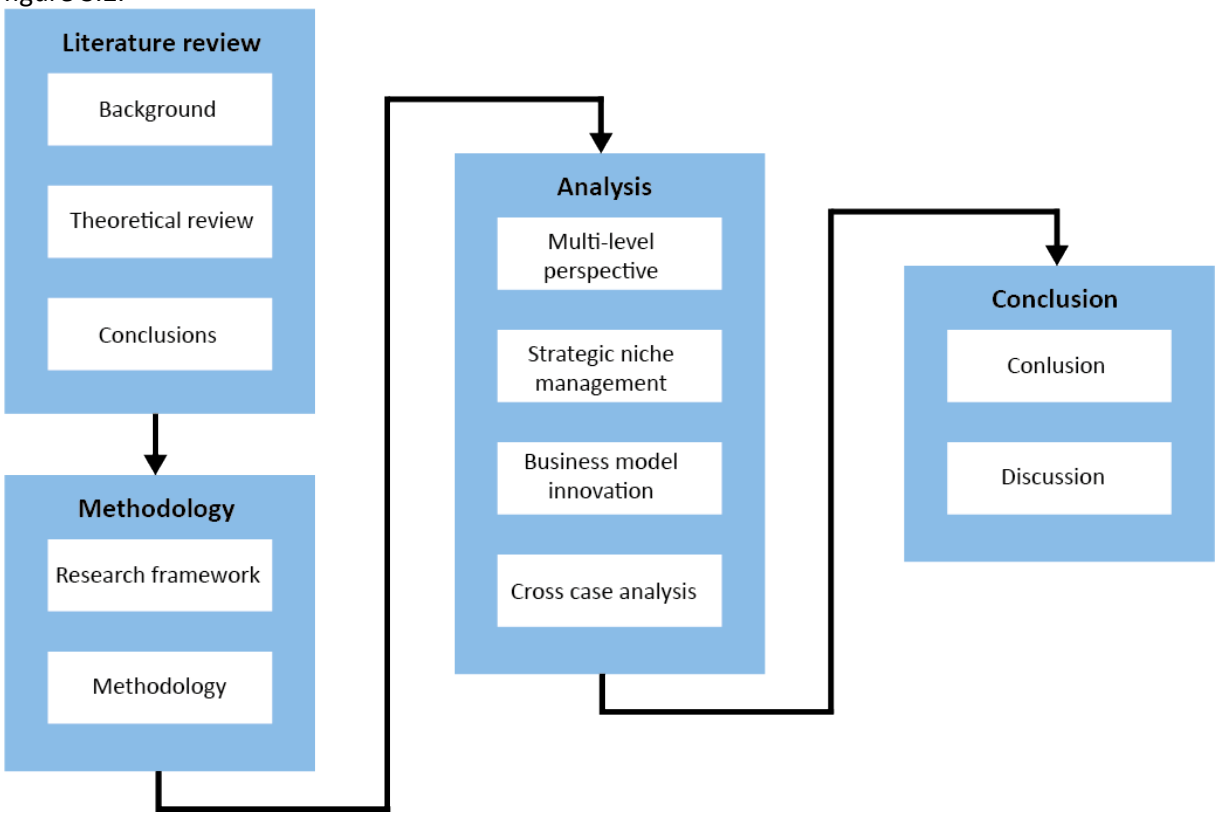


Figure 3.2. Research overview.

## 3.2 Methodology

### 3.2.1 Analytical framework

The conceptual framework in figure 3.1 represents the possible dynamics between different levels of the MLP: the landscape, regime, business model innovation and niche. Chapter 5 will include developments relevant for the MPHW niche on the landscape level and regime level. In the MLP the landscape level is characterized by economic, political and cultural trends on EU level and national level. These trends on the landscape level will be measured to analyze their influence on developments in the regime and niche.

The regime consists of the the Dutch government, municipalities, plastic household waste processors, and organizations responsible for the collection, separation and marketing of the household plastics. The regime will be analyzed to determine the routines, practices, arrangements and agreements that set the course of events of the actors in the regime and consequently the course of the regime. Existing regimes can be altered by a course of innovation that can be technical but can also come from cultural, political, scientific, market and/or industry dimensions. To explore where possibilities for innovation exists in the plastic household waste regime, the progresses apparent in the different dimensions of the regime will be measured.

The state of affairs in the regime can influence trends in the landscape level as well as developments in the niche, just as developments in the niche can in turn influence the regime. Chapter 6 will therefore analyze the developments within the niche of MPHW, in Almere. This niche consists first of all of the municipality of Almere who has created the space for the niche and then the companies that want to do business in recycling the plastic household waste from Almere. The municipality of Almere is both part of the regime and the niche. Almere is part of the regime because that is the way

the current municipal waste management is arranged. Almere is also considered a niche actor as the municipality is essential for the creation of a local MPHW niche.
The business models of the companies are measured according to their value proposition, value creation and delivery, and value capture. It will be evaluated whether the business models are innovative and how they eventually could change the regime, according to the three roles business models can play in BMI.
To explore the developments of the actors within the niche of MPHW, SNM will be used the measure the expectations and visions, networks, and learning of the actors in the niche of Almere. The municipality of Almere is initiator of the local MPHW niche and created a space for the niche to develop. The companies that want to start business within this niche follow. Furthermore there will be reviewed whether the niche is shielded, nurtured and/or empowered by the actors in the niche, as the niche is still in its infancy the empowerment is still a future scenario. When the business models of the companies and all SNM processes within the development of the niche are determined, these will be compared in a cross case analysis between the actors that constitute the MPHW niche in Almere. This analysis will show the differences in business models of the companies and the differences within the SNM processes within the development of the MPHW niche. After the analyses of the results in Chapter 5 and 6 conclusions can be drawn by answering the research questions. An overview of the different levels of the MLP that are included in this study and how these will be measured is given in table 3.1.

Table 3.1. Variables for measurement in this study.

| Level | Variables | Where? |
|---|---|---|
| Landscape | Economic, politic, cultural and environmental *trends* | European Union, the Netherlands |
| Regime | Progresses in the *dimensions* of technology, markets and user preferences, science, culture, policy, and industry | Plastic waste processing regime in the Netherlands |
| Niche | *Internal niche processes*:<br>1 – learning; 2 - social network; 3 - visions and expectations<br><br>1 – shielding; 2 – nurturing; 3 - empowering | Actors involved in the MPHW niche in Almere |
| Niche | *Value proposition*: product / service, customer segment and relationships<br>*Value creation*: key activities, resources, channels, partners, technology<br>*Value capture*: cost structure and revenue streams | Potential niche companies in Almere |

### 3.2.2 Literature review methodology

A literature review is performed to gather information regarding plastics and their waste processing infrastructure. The literature review includes all important research articles regarding recycling techniques of plastic waste to date. Furthermore literature is reviewed to find relevant theory to be able to analyze the developments on landscape, regime and niche level that are of importance for the MPHW niche. To do so Google scholar is used to find relevant scientific literature.

### 3.2.2 Case selection

For the selection of institutions and infrastructure that are in place regarding the recycling of MPHW the boundaries of this research are set to the EU. In the search for actors that are active in the recycling of plastic household waste the boundaries of this research have been limited to the

Netherlands. Only actors that are of importance for developments within the niche MPHW in the Netherlands are included within this research. These actors are companies that want to do business in the niche together as players of importance such as the municipality of Almere, Nedvang and experts.
A webcrawl has been used to search the internet for all innovative companies, in a number of transition agenda's which one of those agenda's is plastics, in order to find all actors active in the niche of recycling MPHW. The webcrawler has been developed by Royal HaskoningDHV and was commissioned by Planbureau Leefomgeving Nederland (PBL) for their report on CE initiatives in the Netherlands (Planbureau Leefomgeving Nederland, 2019). The companies in mixed plastic recycling that were already found by the municipality and the additional companies found through the webcrawler, have been interviewed. The municipality of Almere, the location of the case study, has been looking for innovative actors that see a business opportunity in the recycling of the household plastic waste from Almere. These companies together with the municipality are the actors within the case study.

### 3.2.3 Interviews

The literature research has been the basis for the questions used in the interviews and for the theory to analyze the gathered data. The following companies and actors that have been selected and interviewed: Upp! UpCycle Plastics, BlueAlp, Save Plastics, InGarden, MEPPP, Recycling Avenue, Polytential, Paul Mul, and Tjibbe Winkler. Table 3.1 gives an overview of the selected actors that have been interviewed.

Table 3.2. Actors that have been interviewed.

| Name actor | Company / Institution | Date of interview |
|---|---|---|
| Marchel Marechal | Blue Alp | June 19, 2017 |
| George van der Hansz | Nedvang | November 23, 2017 |
| Rob Lefeber | InGarden | November 24, 2017 |
| Bram Peters | Save Plastics | January 18, 2018 |
| Tjibbe Winkler | Municipality Almere, Grondstoffencollectief | May 1, 2018 |
| Norbert Fraunholcz | Recycling Avenue, Ocean Cleanup | May 3, 2018 |
| Paul Mul | Municipality Almere, Stadsreiniging | May 7, 2018 |
| Jan Jaap Folmer | Upp! UpCycle Plastics | October 12, 2018 |
| Michel ten Bok | MEPPP | October 12, 2018 |
| Yuri van Engelshoven | Polytential | October 22, 2018 |

All interviews have been recorded and consequently transcribed to be able to analyze them.

### 3.2.4 Reliability and validity

The webcrawler search included all internet websites in the world but primarily focused on the Netherlands. In the final results of the webcrawler only circular initiatives within the Netherlands have been selected. From the actors that where selected for this research, five of the eight found by the webscaper were already in contact with the municipality of Almere. By use of the webscraper it can be assumed that the actors interviewed in this study account for most of the actors active within the niche of MPHW in the Netherlands.

To gather most information from the actors in depth interviews were held following a list of open questions, classified by item. The items are based on the found literature in the literature review. The interviews were held in a quiet room. At the start of the interview an introduction to the thesis research has been given together with the aim of this research. The actors have been assured that the interviews will only be used for this thesis research and that the transcripts will not be accessible to anyone else.

# 4. Mixed plastics recycling in a multi-level perspective

This chapter includes the main developments and state of affairs in the plastic waste value chain on the landscape level and the regime level. The landscape level is characterized by international and national economic, political, cultural, and environmental trends. The regime level includes all industries and institutions that are involved in the processing of plastic household waste in the Netherlands. The regime will be analyzed through the different dimensions of policy, industry, market, technology, culture and science. The niche level will be analyzed in chapter 5.

## 4.1 Landscape

There is not yet a clear approach in the EU how to recycle waste plastics, member states differ in their recycling infrastructure and ways in which they process this waste. One of these ways is the export of waste plastics to Asian countries. China, which used to be the biggest importer of plastic waste, implemented a ban on the import of plastic waste. In addition, with the Norway Amendment in the new provision of the Basel Convention, the categorization of plastic waste has been moved from waste that can be traded unless directly contaminated to waste that is subject to trading controls for hazardous waste. This prohibits EU countries to export dirty and mixed plastic waste waste to developing countries (Ban, 2019). However, EU countries do not have the infrastructure in place to recycle all their plastics. Illegal exports within the EU and outside the EU are still happening (BBC, 2019; Gabbatiss, 2018). China's ban and the Norway Amendment are an extra push for the EU stimulate the installation of more recycling capacity within Europe. Plastics will need to be valorized and reclaimed to bring them back into new products. More directives and legislations from the EU will come to guide the percentage of recycled material in new products and to achieve more recycled plastics have to be used in new products. This will encourage the expanse of recycling capacity in Europe and more importantly a rise in the demand for recycled plastics of a high quality. Currently there are a number of guidelines for PET but not for PE and PP. People in Europe act as if they think it is important to process our waste properly but there is still a lack of action in the EU to put sufficient recycling capacity in place. At least the developments in China do reinforce the tendency to stimulate these developments (Fraunholcz, 2018). The EU has great ambitions and performs better than the rest of the world. However, the measure of things is and remains the average performance of the member states, unfortunately this average also ensures that the processing requirements will never be very high.
Brexit could also have an effect on the Dutch plastic waste value chain because currently a lot of plastic waste from the UK is processed in the Netherlands. Therefore the Brexit could significantly disrupt the plastic recycling market with either a positive or negative effect on the the developments in the Netherlands (Lefeber, 2017).

A cultural trend is that countries want to be more circular. There has been a huge increase in awareness regarding the recycling and processing of plastic waste. Countries starting to recognize the problems that come along with plastic waste and start to take responsibility for the separation of their own plastic waste. In the EU and consequently the Netherlands focus is on future prohibition of single-use plastics items and the recycling of waste plastics. More government regulation is being made and implemented that push the market to more sustainable practices. At the same time, big multinationals like Procter Gamble and Unilever state that they are becoming more sustainable. So right now there is a pull from the market and a push from the authorities towards more sustainable practices. Probably the pull from the market is subordinate to the push of the authorities but both sides are pulling and pushing to the right side (Van Engelshoven, 2018).

The price of oil can make or break everything in the plastic waste value chain. The moment that oil prices fall or rise by ten percent, this will cause trend breaks. Lower oil prices have an direct effect on the price of virgin plastics. As a consequence the recycling plastics becomes less attractive from a cost perspective. The other way around, a high oil price could give the recycling of plastics and

market for recycled plastics a huge boost. Tax on the consumption of oil should be much more, the polluter has to pay (Lefeber, 2017).

## 4.2 Regime

### *Policy*

Plastics have been appointed as a priority in Europe and accordingly so by the Dutch government (Mul, 2018). The EU set its ambition to recycle 70 to 80 percent of the plastic waste. When this waste has to be recycled locally, the recycling capacity in the Netherlands has to be tripled (Folmer, 2018). The plastic household waste problem is mainly a political problem and common sense is sometimes hard to find. There happen to be many political factors and institutions that play a role in the plastic waste value chain: the Dutch Federation of Rubber and Plastics Industry (NRK), the Waste Fund Packaging, Nedvang, legislators, processing companies, and the DKR standards. With all these actors it has become a pretty complicated game. Nonetheless, when municipalities or provinces join forces, they can form a larger lobby and exercise more influence on the course of events (Fraunholcz, 2018). Waste separation is not a profitable business, for this reason the Waste Fund Packaging is put in place. The large waste processors get money to separate waste according to certain standards, the DKR standards (Van Engelshoven, 2018). Currently the main incentive to recycle MPHW are the economic compensations municipalities receive from the Waste Fund Packaging to collect and process these plastics, consistent with the DKR standards (Fraunholcz, 2018). Unfortunately, the DKR standards are too low to make anything of good quality from these processed plastics. Recyclers want and need to make higher quality products as nobody is satisfied with recycled plastic road signs anymore (Van Engelshoven, 2018).

### *Industry*

SUEZ, Attero, and Omrin are the large waste processors of household plastic waste and each of these players has their own interests, agenda, and objectives (Fraunholcz, 2018). SUEZ is currently separating the plastic waste into five different streams that meet the DKR criteria, but nothing more. Intrinsic motivation to improve their practices is absent, they comply to the Dutch packaging covenant but do have no incentive to improve any further (Lefeber, 2017). SUEZ has invested millions in their installations and they need to make sure that they earn that investment back. So they need to separate as much waste as possible to reach this goal (Folmer, 2018). In the past the Dutch government has privatized companies with the underlying goal to give these companies space to attract investments and improve their products and services. But this reliance on privatization and the so called ‘invisible hand of the market’ does not mean that these companies will automatically move in the right way, for that to happen proper triggers and regulations should be implemented (Lefeber, 2017). The plastic waste processors currently receive a lot of money, originating from the Waste Fund Packaging, for the collection, separation and marketing of the plastic household waste. Right now there is a lot of money available to make sure less plastic waste is burned; this is the last opportunity for the large waste processors to gain a lot of money and become even wealthier with their current practices (Peter, 2018). Plastic waste processors are really risk-averse in general, especially the smaller waste processors. They are not sure of their future because the value of plastic waste is so dependent on the oil price (Van Engelshoven, 2018).

But a growing number of companies want a circular approach, such as Renewi and Van Werven. These companies realize that moving to a circular approach means they have to cooperate because they cannot do everything themselves. Van Werven in example does not want to collect the plastic waste nor do they want to make products from these plastics, but they are willing to work products from parties that use these plastics (Folmers, 2018). In Nedvangs view the processing capacity in the Netherlands will be insufficient. It is important to guarantee a constant quality and supply to recyclers because they do not like to receive ten kilotons one month and two kilotons the other. For

this reason in Germany the new factories that are being built are a lot bigger, they can process around 200 kilotons. Nedvang expects really large installations to be built, in the Netherlands but especially in Germany. Virgin material is always of constant quality and quantity, when recycled plastics have to compete with these plastics it is important that their requirements are being met (Hansz, 2017).

### *Market*

The plastics market is growing explosively, in 2050 the market is expected to be four times as big as the present market (Ten Bok, 2018). Traditionally the waste business is big business, so most actors are selfish and want to take as much money as possible (Folmers, 2018). Waste processors sell their quantities of recycled plastics already a year in advance. It is therefore very difficult to estimate whether there already exists a markets for recycled plastics because there is no comparative material yet (Van Engelshoven, 2018). Mixed plastics are very thin-walled, mixed together and difficult to clean. There exist niche markets that can use some of these plastics but on a larger scale it proves difficult to find companies that can take large quantities mixed plastics while at the same time upgrading the use value of these plastics. Most often niche markets are created for poor quality plastics and cannot be expected to seriously expand. Mixed plastics have been a big problem for more than twenty years, up until the start of 2018 our plastic waste was just exported to China. At the moment we already face serious issues finding markets for well sorted plastic recycled monostreams, let alone for mixed plastics (Fraunholcz, 2018).

In Germany every product that is designed for the public space needs to meet a lot of testing and specification before they can be taken into production. For this reason in Germany bridge boards made from recycled plastics are not allowed, bridge boards made from recycled plastics do not pass according to German standards. In the Netherlands these standards are much less rigid, this shapes a great opportunity for business with recycled plastics (Peters, 2018). With the overall growth of the plastic market the market for recycled plastics is grows along with it. Consequently there also is a growing amount of companies that have become interested to make products from recycled plastics (Lefeber, 2017).

### *Technology*

Technologically there is always an optimization process between grade and recovery. A higher quality can always be achieved but by reaching a higher quality consequently there will be less material and more plastic will get thrown away. Plastic waste separators like SUEZ, Attero and Omrin search for the most profitable relationship between grade and recovery. However, this is not necessarily what is best for the environment and neither for society. Some new recyclers, like QCPolymers, have to separate post separated waste another time because the main separators do not have an incentive to separate better than the DKR standards as it is not in their economic benefit. The DKR standards are therefore outdated compared to what today's technology is capable of. The standards should be higher, technology can handle it (Van Engelshoven, 2018). Nedvang is currently reviewing the DKR requirements and has put their attention on how to go from a supply-driven market to a demand-driven market. It is important to look at the specifications that the plastics need to be sufficiently recycled and accordingly get an estimation of the demand from the market for these plastics (Hansz, 2017). There is a turnaround in the industry, only two years ago the NRK and the KIVD announced they were to adjust their policy because they want to take the environment into account. Before the NRK has always said that plastics have a lot of calorific value, therefore burning plastic was not bad at all because of their caloric heat (Ten Bok, 2018). Generally innovation does not lie within large companies, they do not invest that quickly. Sometimes these companies do want participate when they spot a business opportunity. However, it is these companies that are the ones that can invest and this investment capacity is of great importance (Winkler, 2018). The large players in the waste processing see where the developments are going. However, the focus of their business cases is to follow the money. Only when the money is targeted on the processing of our own waste you will get

their attention. It can therefore be expected that small and medium enterprises will take their chance and jump between them (Peters, 2018).

Hahn and CABKA in Germany proved that they can make good products out of the mixed plastic stream. But because there is just such an awful lot of plastic waste available they also impose higher quality demands on the mixed plastics they are using. When the manufacturing of products from local plastic waste is proven in Almere, it can be applied everywhere. The applications of the recycled plastics and products made from the recycled plastics also have to be taken into account. A large amount of these mixed plastics are not of high quality. Therefore it cannot be expected these can be used for car parts and products alike. Product developers, architects and designers have to be involved. There has to be collaboration between these actors in the value chain because the products will last a very long time, so they better be good and bit beautiful (Folmer, 2018).

Fraunholcz (2018) noticed a shift in effort to increase the quality of recycled plastics in the past year. Mechanical recycling has its limitations, therefore more and more chemical recycling initiatives are being developed. The solution for mixed plastics will be chemical recycling and the conversion of these plastics into pyrolysis oil and gas. With the ever increasing amount of waste in our cities, chemical recycling seems to be a better alternative to mechanical recycling for mixed plastics. There are already some pioneer companies that chemically recycle PET but they do not yet recycle PE and PP. But facilities to chemical recycle PE and PP are also on the planning. The Federation of Dutch Rubber and Plastics Industry (NRK) expects mechanical recycling to increase from 200-300 thousand tons to 700 thousand tons by 2030. For chemical recycling the NRK predicts there will be around 100 thousand tons of recycling processing capacity by 2030. In the next ten years mechanical recycling is going to get really tough time as the recycling of mono streams such as PE, PP and PET will become bottlenecks. Bottlenecks such as the additives, dyes, small particles that remain in them, and cross-contamination; these weaken the purity and quality of the recycled plastics. There is still room for improvement within mechanical recycling, take a companies as QCPolymers as example, but the next stop will be chemical recycling. Sooner or later the manufacturers of packaging plastics will start to invest in pyrolysis capacity themselves in order to convert the plastic waste into naphtha and use it again for the production of plastics they need. Furthermore they have to accept pyrolysis oil in their naphtha crackers, this is not yet happening (Fraunholcz, 2018).

### *Culture*

In the Netherlands people find it important that the public space is clean and waste is collected; Dutch politicians like to say that “it is all efficiently arranged, there is no litter, the plastic is all carefully collected”. Unfortunately, they tend to forget that in Southern Europe countries it is much worse of a mess (Ten Bok, 2018). The bigger the plastic waste becomes, the greater pressure will be on manufacturers to start taking this into account. In addition, they will come to the realization that it is actually quite interesting to do so (Fraunholcz, 2018).

Past year the Waste Fund Packaging and Nedvang had to work out what to do with the waste chain management of the municipalities in the future. The choice was whether the management would remain with the municipalities, go back to the Waste Fund Packaging and Nedvang, or whether there would be a third option. At first it seemed that control would go back to the Waste Fund Packaging and Nedvang again, because this was the wish of most smaller municipalities. This would be a move back to the old situation where municipalities are only responsible for the collection of their citizens waste. However, a number of municipalities indicated that they wanted to keep controlling the waste value chain themselves. Therefore a third option, some sort of hybrid model with a mix between private and public management has been opted as a possibility. Recently, Nedvang (2019) presented an alternative management model where municipalities can chose to have control over the whole waste processing value chain and still receive the corresponding compensations from the Waste Fund Packaging. So there is an option for a hybrid model. Almere wants to manage their entire

waste value chain in-house: collect all PMD and plastics, sort them, and thereafter use these much as possible in Almere again. In the alternative management model this is now possible. This option is very important for Almere as they will need the compensations that are provided by the Waste Fund Packaging for their own waste value chain management. Therefore the Dutch packaging covenant, that runs until 2022, is important (Mul, 2018).

### *Science*

Chemical recycling offers a large number products that can be made from the MPHW (Fraunholcz, 2018). There is a growth of companies that focus on finding new technologies that contribute to the recycling of plastics. Ioniqa, a spin-off from the Eindhoven University of Technology and the Dutch Polymer Institute, is an example of such a company. Ioniqa is able to chemically recycle PET almost without a quality loss. Chemical recycling cost a lot of energy at the moment but is, if energy consumption can be reduced, better than mechanical recycling (Van Engelshoven, 2018). At this moment Dutch legislation prevents the recycling of mixed plastics through pyrolysis. In the Netherlands the end-of-waste statement is in place, this statement embraces that when a substance or object is a waste material certain administrative and financial obligations apply. Furthermore there are specific rules and permit procedures for the processing, applying and transporting of this waste. In the case of waste plastics this means that at present no diesel can be made from plastic waste in the Netherlands (Marechal, 2018). This is a political dilemma in the Netherlands as with the current guidelines municipalities will not be compensated for their collection and processing of plastic waste if they make oil or other fuels from the plastic waste through chemical recycling. Chemical recycling should be on the agenda of the Waste Fund Packaging to research what compensations are possible for this the chemical recycling of mixed plastics. There is a good chance that naphtha made from plastic waste and used for the production of virgin plastics will be approved by the Waste Fund Packaging as a processing method eligible for the reimbursement of waste plastics. Recycling waste plastics into naphtha would be a better alternative than recycling the waste plastics into fuel. However, this transition towards chemical recycling is not that easily obtained in terms of infrastructure, larger players such as DOUW Chemicals have to accept chemically recycled naphtha in their naphtha crackers to make virgin plastics out of the recycled plastics again (Fraunholcz, 2018). When large players would start to accept naphtha made from recycled plastics these plastics can eventually return, through the process of pyrolysis, to the refinery again. From a technical perspective, plastics can be cracked three times by chemical degradation before their chains become too short (Marechal, 2018).

Urban Mining Corp is a company that makes magnetic density separators. Within magnetic density separation a magnet is placed under tank of water, in this water a nano liquid is dissolved that contains a substance which increases the density of the water in depth. Subsequently plastics can be separated on very small differences in their density in the same tank. Urban Mining Corp is now starting to market this separation technique. This technique can have a lot of impact in the separation of polyolefins, PEs and PPs, which amount up to 50 percent of all plastic waste. This would probably also be possible to do with sensor separation. Within the balance between grade and recovery, magnetic density separation could make a lot of difference (Van Engelshoven, 2018).

## 4.3 Conclusions

On the landscape level the EU member states recognize that they have to improve their waste recycling. The European commission is implementing more policies regarding waste plastics and the recycling of plastics. China closing its borders and the Basel Convention reinforce the tendency to stimulate these developments. The success of recycling plastics is closely linked to the price of oil, with a high oil price it is attractive to use recycled plastics and therefore to recycle waste plastics. This is very different when the oil price is low and primary plastics are cheap.

On the regime level one can see developments in different dimensions. In the Netherlands there is a packaging covenant in which the recycling of household plastics is arranged with industry, municipalities and processors. However, this covenant is no guarantee that the household plastics and MPHW are recycled in the best way. The waste processors responsible for the plastic household waste recycle according to certain DKR standards and have no incentive to do better, it is not in their economic benefit to do so. Luckily a growing number of companies do want a more circular approach, this is important because according to the expectations of Nedvang the Netherlands will have insufficient processing capacity in the future. The large waste processors separate waste according to the DKR standards and Nedvang is looking into the quality of the DKR standards. Technically separation of waste plastics could do better, unfortunately innovation is generally not found at the larger waste processors while those are the companies that have the capital to invest. Recycling companies in Germany and Belgium proves they can make products from MPHW, but because there is too much MPHW these companies select only the best streams. Therefore more products have to be taken into account which can possibly made from MPHW. Another possible option for the recycling of MPHW in the future will be chemical recycling. This will offer a large number of products that can be made again from MPHW. At this moment Chemical recycling should be on the agenda of the Waste Fund Packaging. Nedvang worked out a new management model where municipalities are free to manage their waste streams themselves. For Almere this gives the opportunity to recycle their plastics while also receiving the compensations for the collection, processing and marketing of the waste plastics.

# 5. The MPHW niche in Almere

## 5.1 Almere

### 5.1.1 Municipality of Almere

Almere is a municipality in the Flevoland province in the Netherlands. On the 1st of August 2019 there were 207.819 citizens living in Almere, in terms of population it is the eighth municipality of the Netherlands. Almere is a young municipality; it is founded in the second half of the twentieth century and the first houses were delivered in 1976. Almere is part of the metropole region Amsterdam (MRA) and the prospects are that Almere can still grow towards a total of 300.000 to 350.000 citizens (Almere, 2017a). The overall comfort of the residents is already high because of all the greenery in Almere. The residents take this comfort as a standard and hence this comfort is also high on the political agenda (Winkler, 2018).

By 2020 Almere wants to reduce the residual waste per citizen a year to a maximum of 50 kilograms. In the current composition of residual waste three quarters of the waste does not belong there. These are waste streams such as: paper, plastic, glass, and biofuel (Almere, 2017b). Household waste is property of the municipality and so is the plastic waste. Within the current linear economy more developments move towards a more cooperative economy. However, it is not clear yet how the associated business models of this cooperative economy look like. First, a municipality has to make a clear choice between acting the old-fashioned way, which is to arrange all things through contracts, or to take the lead in forging partnerships and create more value with each other. Almere has chosen the latter and started the Resource Collective Almere (GCA), a collective where profits will be distributed to the involved parties. Almere is investing time and money in the CE. The municipality has learned that CE is still just in its infancy and the only important thing to innovate is to 'just do it'. This way of economic thinking and behavior is different from the common economical behavior. However, the new waste approach is very much tied to the people in the municipality of Almere and still has to penetrate the rest of the citizens. Most people are stuck with old ideas concerning their view on the role of a municipality, the way of tendering and how the economy and accounting are organized (Winkler, 2018).

Currently SUEZ separates the household plastics of Almere and subsequently sells most of the mixed plastics to parties abroad. In Europe there only a few parties that can process MPHW, these are the 'mixed plastic cartel'. At the moment they get offered more plastics than their capacity can handle. Because there are only a few parties and the amount of plastic waste is overwhelming, the prices to process mixed plastics are rising. There is a market failure, there is no party in the Netherlands that can process the MPHW, this only happens abroad. Therefore the Netherlands lost control of the MPHW value chain. In Almere more and more parties are finding each other and start to work together. That cooperation is exactly where the new economy needs to comes from. When working with waste streams the aim should first be on producing a product and a project in which a market party is interested (Winkler, 2018). Almere could show with their new approach that something can be done with plastic waste in every region (Mul, 2018).

Nedvang created room for a local waste value chain with their alternative management model. Now municipalities have the possibility to control their own waste value chain and still receive commissions of the Waste Fund Packaging when they comply to the standards of the packaging agreement (Nedvang, 2019). Almere wants to take the management of their own waste value chain back and steer where and how their municipal waste is processed. The goal is to process their waste locally and show their residents what actually happens to their waste after its collection. It would also offer employment and even the costs of waste processing could be reduced. The main focus will be on waste flows for which there are no good solutions yet, such as the MPHW (Mul, 2018).

Almere does not want to start their own enterprise, they only want to stimulate investment and innovation in the waste value chain. As larger investments ask for certainty, Almere has to make promises over a longer period of time to give this certainty (Winkler, 2018). To do so in the case of plastics, Almere commits to offer the municipal plastic waste as raw material and also purchase back a certain amount of the products that are made from these plastics. Furthermore, Almere will support with the process, location, permits and possible subsidization. Plastic waste will be supplied for a period of ten years and the municipality commits to buy the products made from these plastics for a period of five years (Mul, 2018).
Almere wants to realize their local plastic waste value chain as following: (1) the municipality acts as the supplier raw material, the plastic waste; (2) one or more parties will recycle the plastics into products; (3) parties that want to buy the products, the municipality will be one of them. The province of Flevoland has indicated that they want to play a role in the last part of the chain (Winkler, 2018).
To date there has never been a contract that has been set up this way with a municipality, Almere acts as a pioneer in this approach. Some of the products that will be made from the mixed plastics, such as wall covering and scaffolding, can serve as a material depot. Almere is looking for a processing and recycling facility adjusted to the scale of Almere. To realize this, Almere started an 'innovation partnership' which is an European tendering procedure. This is a procedure to select companies Almere wants to wants to develop the local plastic waste value chain with (Mul, 2018).

There is a pilot project in three different residential districts of Almere. In this pilot waste is separated by the citizens into the following streams: paper, glass, organic waste, and PMD+. PMD+ is a stream where plastic packaging, metal packaging, drink cartons and all other dry materials are allowed. This pilot is in order to reduce the residual waste waste per inhabitant in to 50 kilograms or less in 2020. The waste from these three districts is post-separated in the Vijfhoek. On behalf of Almere MEPPP has performed a feasibility study on the composition and quality of plastic waste collected in the three districts. From two of the three districts the quality of collected plastic waste was suitable to make granulate. Almere wants to make different degrees of granulate from the mixed plastics, ranging from low to high quality. The quality of the granulate that is needed depends on the products that will be made from it. In example, building materials can do with a low quality, scaffolding and wall covering need a higher quality, and pallets and crates will need a high quality. To make different qualities of granulate, mixed plastics act as the basis for each of the granulates and quality will be improved by adding recycled monostream plastics (Mul, 2018).
The Engineering Office of Almere (AIB) is responsible for all projects in the public space of Almere and wants to make upcoming projects circular, one way or another. To do so, they are currently investigating which materials from residual streams in Almere, such as plastics, they can use (Winkler, 2018).

In figure 5.1 an overview of the possible options Almere can implement to reach their plan for a local plastic waste value chain are presented. The blue flows are the plastic waste streams that could be used, to know: (1) the plastics from the pilot districts, (2) plastics separated from residual waste from high-rise buildings, (3) get the plastics back from Nedvang after their separation at SUEZ, (4) plastics from waste in public space. After the waste is collected it will go through a sorting installation where plastics are separated from other material streams such as organic wet fractions in the waste, wood, stone, metals, beverage cartons, and electrical and electronic equipment (EEE). The plastics can be separated into hard plastics, residual waste, monostreams and mixed plastics. The mixed plastics can be used by the actors subject to this research. BlueAlp can chemically recycle the plastics back to oil and naphtha, the other companies will need a pellet factory where regranulate pellets will be made from the mixed plastics. This regranulate can be used for a variety of products such as transport pallets, scaffolding and other products to be used in the public space (Mul, 2018).

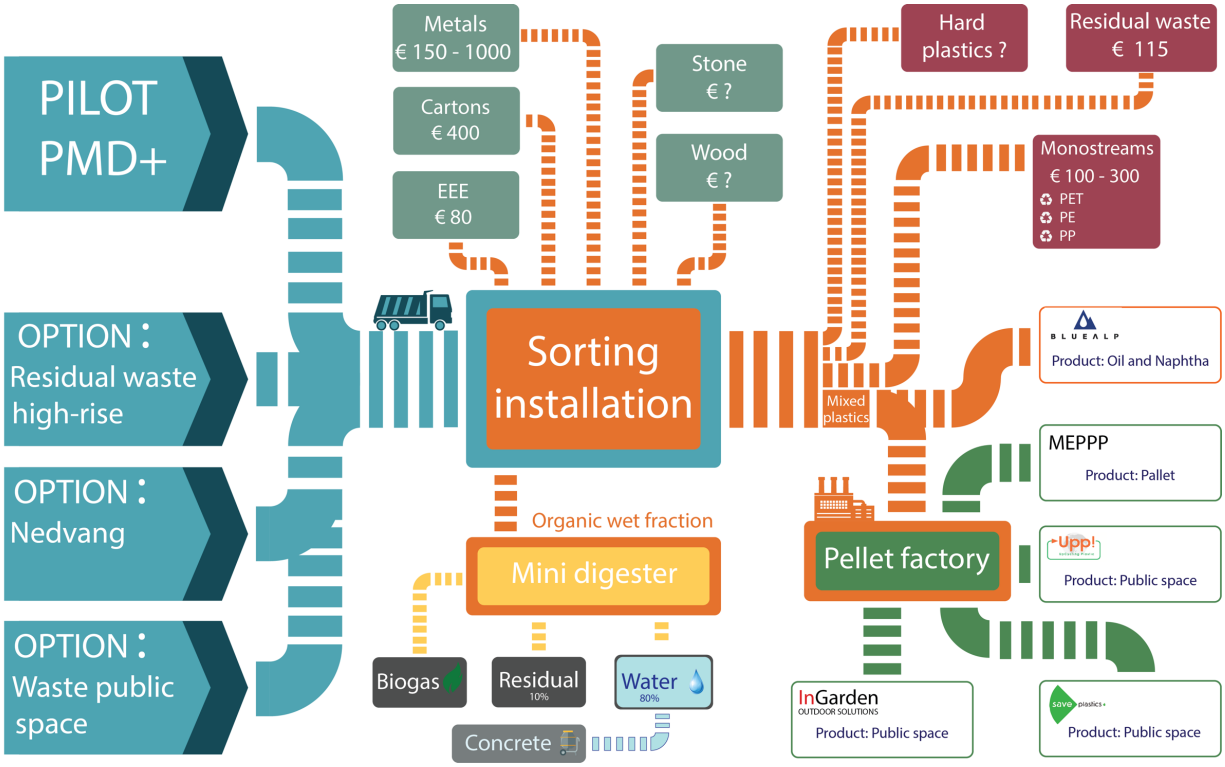


Figure 5.1. Local plastic waste value chain in Almere.

### 5.1.2 Almere Resource Collective

In June 2017 Almere Resource Collective (GCA) has been founded. The focus of GCA is on the development of raw materials from waste. The GCA was founded by three local parties: the municipality of Almere, the Vijfhoek and Millvision. The municipality owns the residual flows, the Vijfhoek acts as a physical location where the residual streams (former waste) are stored and processed and Millvision is responsible for new circular products. Since the start of GCA already 40 project partners have expressed their commitment. The collaboration is based on the application of a CE, this can be done by reuse but also by processing the raw materials into new products. The local aspect gives an impulse to the business community; new financial flows, intensified partnerships and more employment (Grondstoffen Collectief Almere, 2018).

### 5.1.3 The Vijfhoek

In 1989, five road construction companies, in consultation with the municipality of Almere, took the initiative to set up Recycling Company Vijfhoek Flevoland B.V. The waste that was produced by these five companies became the objective of the Vijfhoek: process the waste to make it suitable for reuse. When the Dutch landfill ban for construction and demolition waste came into force in 1997, the Vijfhoek received the required Certiva certificate. With this certificate the Vijfhoek is now a recognized recycling company. Because of the general landfill ban, companies from the region started to offer their waste at the Vijfhoek. From that moment the Vijfhoek started working as a waste processor for third parties. Nowadays, the Vijfhoek has grown into a well-developed waste service center where waste is being sorted and recycled. Because the Vijfhoek is categorized as an recycling company the area serves as an experimental area for new developments and innovations regarding recycling. The Vijfhoek set its goal to respond to social developments such as sustainable recycling methods, a healthy living environment and improving working conditions. Companies that together own the recycle company the Vijfhoek are: Reimert Bouw en Infrastructuur, Van Werven, Theo Pouw BV, Millvision, and Groen Gas Almere (Vijfhoek, 2017).

Almere wants to use the Vijfhoek area for the recycling of their household waste plastics. In collaboration with GCA and the Vijfhoek this is a good space to experiment with sorting and processing of plastic household waste from Almere. The municipality has taken on the role of creating a safe space for innovation, the Vijfhoek, in collaboration with the parties that founded the Vijfhoek. The municipal cleaning of Almere feels responsible for the waste of Almere and the consequently waste problem (Winkler, 2018).

## 5.2 MPHW niche actors

The following actors are present in the niche of MPHW and provide in technology to recycle MPHW.

### 5.2.1 Recycling Avenue

Recycling Avenue is founded by Norbert Fraunholcz and is a technology consulting company in the field of plastic recycling. The last ten years Norbert specialized in plastic recycling and all kinds of processing techniques which are optimal for the processing of certain plastics. Norbert has been intensively involved in mixed plastics and packaging waste in general. Norbert has been the Chief Technological Officer for the Ocean Cleanup where he used his expertise and focused on the recycling of mixed plastic waste that ended up in our oceans. These plastics are mainly PE and PP, at Ocean Plastics they are investigating techniques that can be optimal for the processing of these plastics. These plastics have the property that they are heavily degraded. To recycle these plastics there has to be done a lot more than to ordinary packaging waste which is not degraded and high quality compared to the ocean plastics (Fraunholcz, 2018).

When there will be a local market for plastic scaffolding and wall covering and these products can be sold in Almere and the Flevoland province, this is different to the situation where these products have to be sold in the big market that is already overflowing. If Almere can keep everything in their own hands, their own waste, their own processing, their own sales market, and make it feasible then they are autonomous. This will be a completely different business case than when Almere is dependent on the waste processors that are third parties and depend a sales markets that currently exist outside the reach of Almere. However, Almere is going to have a hard time with the recycling of MPHW. In the coming years their supply of recycled products will only get bigger and parties make and will make only the same kind of products. Because the processing capacity of mixed plastics is lagging behind, mixed plastics will be abundant and therefore competition will be too. It depends on how Almere will approach their own waste collection and processing infrastructure and whether this is economically feasible (Fraunholcz, 2018).

### 5.2.2 Polytential

Polytential makes a quality analysis tool the ‘Virtual Chemist’ that can be used by plastic waste recyclers that process plastic waste. The Virtual Chemist is a device that makes use of sensors for the analysis of plastic waste. By doing this the Virtual Chemist is able to give detailed information about the composition of the plastic waste. The tool can provide in a quality analysis that provides an insight into the contaminations that are present in the material after it has been separated. With this information about the composition the user can determine the best use for the plastic waste, whether that is scaffolding or a buggy.
Polytential has a broad network. Some of these actors that made their existence possible are: Climate KIC, YESDelft!, the supplier of their cameras and sensors, NRK, and Norbert Fraunholcz. The tool is mainly focused on the mechanical recyclers where companies such as SUEZ, Renewi and van Werven sell their separated plastic waste to. Their next customers will be the separators. Provinces and municipalities are not considered it as main customers yet because, they are considered more of a subgroup. Nevertheless, Polytential is going to approach these parties too as they could profit twice because both Nedvang and the municipalities need to know whether the DKR requirements are being met for the commissions (Van Engelshoven, 2018).

Yuri van Engelshoven is responsible for the financing and the operations. As Yuri is most familiar with recycling within the company, he is also gives direction to long-term developments. As of this moment Polytential is working on transforming their prototype into a product that is available for sale, they expect to be ready in February 2019.
Polytential is involved in the Climate KIC accelerator program. However, most of their funding comes from subsidies. They have raised almost half a million euros over the last two years, of which a quarter of a million is a loan. On the other hand they receive donations from the provinces and from the government. They fall within the top sector policy, including chemistry, are innovative and put effort into making the sector more sustainable and can therefore apply for a subsidy (Van Engelshoven, 2018).

The market is fairly conservative, avoiding risk. There is a lot of uncertainty from the fluctuating oil price but there is also a big difference in the quality of the plastic waste. For smaller recyclers is is therefore difficult to make financial commitments because they are not so sure of what is going to happen. Most recyclers do not like new developments, they are a bit conservative and old-fashioned. As a result the plastic recycling industry lags behind the technologically driven industry. Polytential is dedicated to make the recycling industry much more data driven, not only in terms of separation and analyzing but also to register where recycled waste ends up. Most recyclers have no incentive to deliver a high quality final product. But demand is growing for recycled material good enough for high-quality products. Polytential wants to facilitate a matchmaking process where all the plastics of a large region are collected, to determine which plastics should go where based on their qualifications and the product they are needed for (Van Engelshoven, 2018).

If mixed plastics are turned into products with low dignified requirements such as scaffolding and wall covering , plastics will be mixed together. This will eventually result in a black product or a very dark product which you can never make another color again. When all those different plastic are mixed together, mechanical recycling can never assemble the different kinds anymore. It is uncertain whether it makes sense to store waste plastics now to wait for a better moment. Therefore it is not a good idea to turn all mixed plastics into low quality products, unless in the future chemical recycling can recycle these plastics again. When Almere really wants to invest in machines, it could be a great opportunity to recycle their plastic waste. After all separation there is going to be a bloodstream that they cannot do anything anything with, that is would be a good waste stream to make scaffolding and wall covering from (Van Engelshoven, 2018).

### 5.2.3 BlueAlp

BlueAlp is located in Eindhoven and acts as a separate company but actually belongs to PetroGas. PetroGas exists since 1949 and is a well-established company that has been active on the fuel market for more than 60 years. BlueAlp is a technology provider, especially in the field of measuring and control installations, but also for biogas and steam applications. In 2002 PetroGas cooperated with BMW and this resulted in a new project in Switzerland concerning a Pyrolysis installation. PetroGas became involved in this project and when their bills couldn’t be paid by their client they suddenly owned a new technology and a new division. For this reason BlueAlp has been founded.
Large companies are not interested in investing in an chemical recycling themselves, they rather leave this to the market. BlueAlp has talked a lot with waste processors but they seem not to be interested in the installations that BlueAlp can built. They want to keep mechanical recycling. But the lower you go down on the quality of the plastics the more difficult it is to process them. Right now the price of diesel through the process of pyrolysis is around 38 cents on the market. BlueAlp offers a business model with which more than 10 percent per year can be generated. This way payback time of the investment can be done in a relatively short time. Banks do not find this attractive, because the technology is still in a start-up phase, they act risk averse.

BlueAlp got involved into the technology of pyrolysis by a concurrence of circumstances. Nevertheless, they do realize it is important to invest in new technologies as oil prices are going down, this makes it necessary to focus on other markets such as converting waste plastics back to oil. BlueAlp has succeeded in getting their pyrolysis installation up and running. The diesel, made from post-consumer plastics, that comes out as a product meet all the requirements in terms of environmental and standardization of the diesel, it complies with EN590. EN590 is the standard of physical properties that diesel fuel has to meet to be sold in the EU. BlueAlp can make 70 to 80 percent fuel of these plastics if the mix is good. For a good mix there is a max of PET and PVC that can go in, therefore the pre-sorting is important. The process results in four product streams that could be optimally tuned. The first stream is the heavy fraction, the fuels, the marine fuel and diesel. The second stream is the light fraction, light hydro carbons (LHC), gaseous and can be used to heat the boilers within the process. The third stream are non-condensable gases. And the fourth stream will flow from the previous streams and consists of char, bitulen, hard parts and black sludge. The market is at the moment interested in naphtha, these are the lighter fractions found in the second stream. So instead of concentrating on the diesel BlueAlp now concentrates on naphtha, a stream that consist up to 75 percent of naphtha. Naphtha is also used in the chemical industry, and the chemical sector is searching for green flows in their processes (Marechal, 2018).

At this moment, the quality of the plastics SUEZ separates is not yet good enough to go through the installation without pretreatment because there are always tabs of the sandwich bags and such that are disastrous for the pyrolysis process. Therefore pretreatment is really important. After the pre-treatment the melting takes place, here the plastics are heated and run through a number of screws so they are mixed well. Next it will go through a number of heat exchangers to reach the right temperature and volume to crack the plastics. Here the plastics are separated into the four different streams. Then it will go into a distillation column where at a given moment the heavy product comes out. Next it goes through a condenser where the gases are collected. The requirements for this installation are cooling water, thermal oil for the heating and cooling of the cracker. There will be a stream of waste water, this is a waste stream from the chemical reaction during the cracking. For this waste water stream there exists a waste-water treatment. At the moment most of the generated heat is used again in the processes within the installation. There are possibilities to create symbiosis between other installations and the pyrolysis plant (Marechal, 2018).

## 5.3 Almere niche actors

The following actors are present in the niche of MPHW and want to make products in Almere from the MPHW.

### 5.3.1 UPP! UpCycling Plastic

Upp! UpCycling Plastic is a start-up company located in Zuidermeer. Upp! is working on the development of a number of projects to close the local plastic waste cycle in both the Netherlands and Vietnam. Jan Jaap Folmer, the founder of Upp! has been exploring recycling opportunities in Vietnam for the last two years and is involved in four projects regarding collecting, separating and processing plastic waste. Jan Jaap also worked as commercial director at Lankhorst, a reputable producer of plastic products made from recycled plastics. Upp! does not have their own production installation yet, at the moment they outsource their production to other companies such as Govaplast and ECO-oH! in Belgium.
Jan Jaap describes a CE as an economy where we do not produce waste anymore, it is the future. According to Jan Jaap the projects of Upp! in Vietnam have the same goal as Almere: to convert local waste into products that can be applied locally. Single use plastics will decrease in the coming years so the composition of the plastic waste will change, but the production capacity of virgin plastics is still increasing every year. So, for the next ten years there will will be large volumes of plastic waste on the market. We need to switch to a CE if we still want to live on our planet for 100 years.

The recyclability of a product is closely intertwined in the design of a product, products need to be designed in such a way that it is easy to disassemble them again. By design a wooden plank combined with plastic can be beautiful and recyclable. Plastic products reinforced with steel are a different story, they are difficult to recycle because they contain steel wire. When recycling cost are too high compared to the final price of a product it is impossible to make competitive products. However, when entire bridge constructions and scaffold constructions can be made by using steel reinforcements, their cost-benefit ratio should be considered.
To make high-quality products from mixed plastics, the plastics need to be mixed with fractions of recycled plastic mono streams to reach a sufficient composition and quality. However, Hahn and CABKA in Germany proved that they can make good products out of the mixed plastic stream. The objective of Upp! is that their business should be as circular and local as possible. It needs to be an integral approach to the entire chain with the goal to process as much as possible of the plastic waste. Almere wants to get more value out of the mixed plastics, which are now useless, and process these. Upp! can use the entire stream of these mixed plastics.
At the Vijfhoek all companies are all involved in circularity, so there are various possibilities. The plastic waste from the pilot in Almere that is post separated at the Vijfhoek outperforms the DKR requirements and consequently the standards of SUEZ, Omrin and Attero. Almere wants to apply this waste system in the whole municipality. Therefore Almere wants to build a post-separation plant in the Vijfhoek as well. In the future there should be an separation installation that can sort between 15 and 20 kiloton a year. Almere is offering Upp! a real chance to realize a plastic factory, also with regards to permits, their network and with the entire infrastructure on the Vijfhoek (Folmer, 2018).

### *SNM*

#### *Expectations and visions*

There will be an enormous demand for plastics in the coming years. It is absolutely unforeseeable whether Upp! as a start-up can keep up with this growth. The goal of Upp! is to save at least 250.000 tons of plastic waste from incineration, landfills and oceans by 2025. In the global scale of the problem this amount is still a drop in the ocean. Upp! tries to find use for these plastics and to apply these as circularly and locally as possible. (Folmer, 2018).

In Almere Upp! wants to have a relatively small factory of 5.000 tons per year. That is the same quantity Lankhorst and Govaplast do on an annual basis. It is only a small factory, because it amounts for only a quarter of all sorted plastics from Almere and the surrounding area. When Upp! will take the plastic waste flows from other places such as Renewi at Schiphol and Landal Greenparks, they already need to scale up before they even started building in Almere. A decent capacity is needed to process the lesser quality plastics. Upp! is convinced when they get their business to work in Almere, other governments and companies want to get involved. They hope that in 2023 they will have five operative processing factories (Folmer, 2018).

#### *Social networks*

Within the waste value chain sorting is important. But it is even more important that there is good communication between the different actors involved in the sorting processes. The Netherlands cannot be filled with only wall covering , benches and flowerpots of recycled plastic waste. There should be market research for new products, conversation should be started with possible buyers such as municipalities, provinces and companies. These actors have to get involved and think of products they really want to have. In these conversations the municipality of Almere is one of the parties Upp! is talking with, but they also in conversation with the Schiphol Group. The Schiphol Group has a lot of waste and came to Upp! with the ambition to recycle this waste in a sustainable way as locally as possible. So Upp! wants to make products for Schiphol made out of their waste. Upp! is also in conversation with Renewi which has a contract with Landal Greenparks. At the moment Upp! is looking for a number of demo projects to start somewhere and show their concept works. After proof of concept they can scale up to industrial production (Folmer, 2018).

Upp! preferably deals with local authorities because they want to close the circle locally. Local governments are important because they play a role in the collection and delivery of the plastic waste and are large potential customers. Many products for the public space, infrastructure and construction could be made of waste plastics. For these products the government is often an important actor and is therefore an important partner. The municipality of Almere has not yet issued the guarantee to purchase products, but Upp! thinks they will do so. The CE is an economy of cooperation, companies in the waste value chain do not directly work as a competitor. Renewi is working on all kinds of circular concepts, sustainability and recycling. There are collection companies, separation companies and processing companies such as van Werven in Biddingshuizen and Morssinkhof in Zeewolde. Those companies are important in the network, if work can be done in collaboration with them this is only good as one company cannot do everything alone. In example van Werven could recycle the hard plastics and when Upp! would need these they would be able to retrieve them from van Werven again.
Collaboration is key to get things to work. Therefore Upp! wants to involve universities, colleges, educational institutions and research institutions. The plastic factory should be a collaboration with Aeres Hogeschool in Almere, Windesheim and the Polymer Science Park in Zwolle. All actors need to be involved in to the process, the government, companies, the residents of Almere, education and research institutions. They want to create a space where students can develop new applications and new products and to continue studying for new opportunities. Therefore Upp! wants to name their factory the 'Circular Plastic Experiment Center'. The purpose of this center is not just for the production of products but also as a space for innovation. A place where Upp! wants to work on new technologies and other production technologies. They want to start experimenting with 3D printers, vacuum molding and with new mixes of materials. Local designers will be involved for product design tailored to the specific needs of Almere. The people of Almere need to be involved too as they should be shown what actually happens to their plastic waste. It is important that there will be a visitor center, this wat people are able to take a tour through the factory, the lab and the experimental spaces so that people can see what happens and how it happens (Folmer, 2018).

*Learning*

Your network is incredibly important and it takes a lot of time to develop it properly. As a start-up the first few months people find you very interesting but do not take you seriously. Only when you are concretely engaged, as is the occasion for Upp! with Almere, you are taken more seriously.
At the moment the production of Upp! is in cooperation with two other companies: Govaplast and ECO-oH! in Belgium. ECO-oh! does the reprocessing of household plastic waste themselves, which proves Upp! it is technologically possible. In the technology, there is initially little news under the sun. Upp! only brings it together and wants to make sure that it is approached in an integral way (Folmer, 2018).

Upp! believes there are a lot more possibilities in the tenders than Almere is offering at the moment. Municipalities can do a lot more themselves by simply saying they want to buy circularly. It is best for them to include in a specification that they want to have benches in their municipality from their own plastic waste. When Upp! gets to hear that they are allowed to build the plastic factory in Almere they know almost certainly that investors are in line to invest. A start up always seems to have to go through a Valley of Death. In the beginning it only needs money and only after a while as business starts running, money is earned. It is not the goal of Upp! to become filthy rich. Instead it is the intention to set up something that is commercially sustainable, self-sufficient and which can get as much value and grow as quickly as possible. They think the potential is huge (Folmer, 2018).

Almere requests all kinds of information from the potential start-ups because for them the start-ups are small and pose a big risk compared to business as usual, the way SUEZ, Omrin and Attero do business. Many municipalities and provinces in the Netherlands are watching the developments in Almere, they show a lot of interest. The province of North Holland would like to join, the MRA

municipalities too. The price Upp! has to charge for their products is based on the price of the raw materials, sorting, washing and grinding. The final price is than the cost price plus a margin. The goal should never only be to be the cheapest but instead it should be on delivering a good price quality ratio. If there exists a better collection system, the municipality will save millions per year in the collection of plastic waste. As a company you have to make sure that you can run your business well and that it can be done commercially. Your price should always follow the market because you have to be able to compete. However, in the comparison of the startups in the tender of Almere encountered there was an indicator on the price of products. Candidates had to put a price on a number of products. Upp! stated they could not do so because they simply do not know what kind and quality of product the municipality exactly wants. In the dialogue sessions with the municipality Upp! therefore noted that putting a price on a product would be a unfortunate indicator for comparison. Eventually, Almere did not include this indicator. In this occasion Almere thought it had to include this indicator because that is in line with these conventional tendering rules (Folmer, 2018).

#### *Business model*

##### *Value propostion*

The value proposition of Upp! is to make products from household waste plastics and to process as much plastic waste as possible. Their main customer segment are municipalities. When Almere is able to deliver the quality of waste plastics they currently do in their pilot, the fraction of mixed plastics will be much smaller. Therefore Upp! wants to make a range of products from low to high-quality products dependent on the quality of the waste plastics. The products that Upp! can make for Almere are wall covering and scaffolding and furniture for in the public space (Folmer, 2018).

##### *Value creation*

Upp! will create value by recycling the household waste plastics of Almere through the extrusion of MPHW into products. Upp! wants a demo project or a few of those projects as soon as possible. As soon there there is a proof of concept they want to build larger factories. They will involve product developers, architects and designers for the products they are going to make. They recognize that communication between these actors is important, as the products will last quite some time they better be good and also a bit beautiful.
Upp! wants to involve blockchain to make all information transparent and clear for all involved actors. Blockchain could give actors the necessary information and confidence to start co-operating. The big advantage of blockchain is that you can see where a product is at any time while it is also transparent everyone involved. Products can be tracked well and this will boost the circular system because there is not lost track of the products. In Almere Upp! wants to implement blockchain for the creation of a plastics commodity bank.
Upp! stores the MPHW in their products, this way pollution and $CO_2$ will be stored. Eventually there might be another technique in the future which you can apply to do something different with the mixed plastic waste. Upp! really wants to show that the local plastic factory in Almere can actually be done, the quicker the factory is there the better (Folmer, 2018).

##### *Value capture*

Value will be captured by the recycling of plastic household waste into products and selling these products back to the municipality where the waste finds its origin, in this case Almere. The costs to start the project in Almere for the machinery is around 100 to 200 hundred thousand euro (Folmer, 2018).

### 5.3.2 Save Plastics

Save Plastics is a family business located in Arnhem. Save Plastics has a total of six employees and is still growing as a company. Save Plastics is founded by the father of Bram Peters as supplier of plastic poles and planks. Bram defines CE as the process where a product is been made and after its disposal

the same product can made from it, without emissions and loss of energy. CE is the tool of the new economy and is applied, but we still need to get there. Many companies use the word 'circular' just like they used 'sustainable' in the past, but the way use the word is rather greenwashing. Bram points out that the linear economy produces huge amounts of waste. CE is the economy we need to go but in an intermediate period CE should also use the waste of the linear economy. The goal of Save Plastics is to use the MPHW waste stream and turn this into products for the public space such as water casings and scaffolding. Save Plastics has been around for some time and they are experienced in the use and processing of plastic waste streams. They work together with Hahn which is an plastic waste processor in Germany. Together they are basically the largest producer of products from mixed plastics in Europe.
The new economy is a difficult process, there needs to be a kind of organic amalgamation. Nowadays, Save Plastics is doing business in a multidisciplinary manner. They have important contacts that are active in different fields such as waste, environment, geotechnical engineering and politics. Save Plastics looks rational to the developments in Almere, they are responding to growth in demand but meanwhile keep up their revenue model with their production partner Hahn in Germany (Peters, 2018).

Save Plastics already made the transition from the old to the new economy but their customers do not really care about that yet. So they need these contractors, which are their customers, wanting to have their poles being made from recycled plastic instead of primary plastic because this is environmentally responsible. Most products of Save Plastics are cheaper than primary products but as soon their products are slightly more expensive some parties drop out. Parties whom are interested and also want to be circular are their real customers. The proposition of Save Plastics is: "make your own plastic your own stuff". When Almere wants to recycle all their plastic waste into products for the public space they will end up producing shelters, bridges, scaffoldings, wall covering and benches (Peters, 2018).

### *SNM*

#### *Expectations and visions*

Save Plastics wants to save two and a half million kilos of plastics a year by means of partnerships in municipalities. They want to they translate the ambitions of municipalities ,in the field of CE of plastics, into products. Their vision is to become circular 2.0, that encompasses is the production of proven products from your own waste together with social employment. Alongside products for in the water new products will be designed. In Arnhem, there is little water and now Save Plastics is supplying all the bank boards (Peters, 2018).

#### *Social networks*

For Save Plastics the ambition of politics is important. They see ambition as money, resources, energy and time invested. Save Plastics believes that we are already at the end of the funnel. The ambition is there and it is time for policy to be written out. Putting policy in place will take time and money. Save Plastics thinks they are on the right side of the transition from a linear to a CE. At the moment they are waiting for municipalities and waterboards to start buying products made from their own waste plastics. They notice that projects are about to fall such as the new projects with Diergaarde Blijdorp and Natuurmonumenten (Peters, 2018).
Save Plastics is part of the Plastic Fantastic cooperation. Plastic Fantastic is created as a cooperative, there are people from TU Delft, engineers, freethinkers, a college, a landscape architect and Save Plastics in it. Plastic Fantastic is a sustainable partner of the Ministry of Infrastructure and Water Management and they contribute to the green deals that are made. Together, the cooperative will grow, soon the Ocean Plastics ambassador and other actors will join. Plastic Fantastic is looking for a solution together, the parties involved invest in the cooperation, CE costs a lot of money. You can be circular for a few bucks, but being really circular costs money. Plastic Fantastic has built a mobile factory, with this Factory they across conferences and parties to show it is possible to make products

from waste plastics. Plastic Fantastic is mainly focusing on litter, which is a leak in the waste streams due to legislation and the Dutch packaging covenant. Litter is not certified, it is property of nobody and there are no contracts (Peters, 2018).

Save Plastics always goes to the source of the plastic waste and does not go to the larger processors. In the case of Almere they will see what they can work out. Optima forma that would mean that the pile press has to be in Almere. But with one press they would only be able to make poles and not the facing. Furthermore, they also want their products to be UV stabilized for a certain lifespan. For Save Plastics there miss actors that do have the budget to develop the factory. Actors that really want to solve the plastic problem. This could be the municipality of Almere. When they would put plastic waste on the agenda and say “we are going to invest half a million in the next five years in scaffolding and wall covering” that would be enough for Save Plastics to invest (Peters, 2018).

#### *Learning*

Save Plastics learned how things exactly work at the official level in Almere. They noticed that there are a few leaders in Almere who say “this is going to be”. Without these people you are not going to make it in a municipality. However, the plastic factory in Almere still has to be fought for along multiple islands within the municipality. Save Plastics learned that provision of information is what is required from them to make things succeed. Take the MKI value of their products as an example, they have not worked out these yet. Due to a lack of information several projects ended up on the stack, this a is a bottleneck for Save Plastics (Peters, 2018).

Within a project there is a political ambition, policymakers who translate politics into policy, then there are the bookkeepers and you have the executive party, the engineers whom ultimately have a lot of influence on the process. The engineers are not involved within this process, Save Plastics thinks that is a good thing, because when politics suddenly come up with an idea it is not guaranteed to work. People who translate such a new ambition into a project are important people. However, it is mostly these people that tend to act traditional and risk averse. In the case of Almere, Almere should say “let's do a pilot project”. It is such a big municipality, there is always something that can be done (Peters, 2018).

Peters is surprised that the municipality of Almere keeps talking to them as a potential competitor. In fact, with the goal of Almere to start a local waste value chain, Almere should say “you cannot join when you do not fit the mold”. Van Werven, one of the founders of the Vijfhoek, warned Peters about progress made in collaboration with the municipality: “it is two steps forward, one step back” (Peters, 2018).

### ***Business model***

#### *Value proposition*

The value proposition of Save Plastics is in supplying plastic poles and planks. Traditionally, shore covering is their number one product, the combined wood and plastic poles account for the most sales. Second come scaffolding planks and third place come purlins as collision protection and for in water channels. All the products of Save Plastics are used mainly in the area of water. They have experience in the use and processing of plastic waste streams. The customer segment of Save Plastics are local governments such as municipalities but also amusement parks and the organization for nature conservation (Natuurmonumenten) are customers (Peters, 2018).

#### *Value creation*

Save Plastics creates value through product design, it is all about the product. At the moment they are becoming more product-dependent, they are now also busy with cladding and hope this move will deliver a lot of turnover. They manage the raw material flows, waste plastics, where their products are made of. Their products are made by the extrusion of waste plastics. Save Plastics

recently started to name all raw material steams that are apparent in their products in a product passport.
Save Plastics recently started to name all raw material steams that are apparent in their products. As a company they are the last link in the waste value chain, the plastic waste streams that remain or normally goes to the incinerator is their resource. This stream is stripped of the plastic bottles, PVC and the valuable plastics. The residual flow that is left is the one Save Plastics currently uses, this a flow that consists at least for 75 percent of polyolefins. These are the plastics found in foils and plastic bags and are also precisely the plastics that are the basis for their products, that is the business of Save Plastics. The sorting practices of waste plastics are getting better, consequently the quality of the residual flow is getting worse. For Save Plastics this is a challenge because they also need to keep up improving their practices. Of course at a certain moment these improvements stop as the residue stream will be too small and dirty. Their ambition is to save two and a half million kilos of plastics from being burned a year. Save Plastics is a joint venture together with their partner in Germany, Hahn. Hahn produces the products for Save Plastics from the plastic waste Save Plastics manages. In Germany they process 45 million kilos of plastics per year, that is 45.000 tons. At the production plant of Hahn Save Plastics has 35 molds for the products of Save Plastics. Save Plastics manages the raw material flows where the products are subsequently made of. Right now Save Plastics has 950 profiles for their products but no Environmental Cost Indicator (MKI) value certifications for their products. When they have to do an MKI for every product they will go bankrupt (Peters, 2018).

In a new project Diergaarde Blijdorp will give Save Plastics five thousand kilos of waste foil and in turn buy fencing boards and bridges made from these foils back. Save Plastics also nearly has a deal with Natuurmonumenten, whom have 10.000 hectares of nature which suffers a lot from litter. Natuurmonumenten also have wood. Save Plastics will turn the litter and wood into combi poles: the sleeves are made from litter and the inside from wood. Natuurmonumenten can use these poles in their nature parks for at least 40 years. The surplus poles will be sold on the market and the revenue of these sales will be used to certify the products. This way they will have a good product that has its origin in one place, something SUEZ cannot beat.
Save Plastics is also working on a new model where they offer products as a service. In this model Save Plastics keep their products in ownership in a lease model. But for this model they will need a lot of money, so that is what they are working out now (Peters, 2018).

*Value capture*

Value is captured by the delivery of products. Currently they are delivering a lot of combination products. For Almere they find their new product, the vertical sheet piling, have a lot of potential. In this product the wooden board has been sprayed with plastic, the upper water piece is made of plastic and the underwater part of wood. Save Plastics is going about to start making that product now. At the moment Save Plastics gets the plastic waste for free but costs are made for the molds to be built and maintained. The start-up costs are very high. These costs include the purchase of the mold, the processing, raw materials, preparation of the raw materials, marketing and the six employees that work at the company. Save Plastics has about two million in revenue per year, if they have a net margin of one percent, that is already a lot for them (Peters, 2018).

### 5.3.3 InGarden

InGarden is a company that has their own factory in Zeewolde. InGarden is founded by Jan Schulp and started as a retailer of the Swedish brand InGarden. For InGarden a CE is an economy where we leave the linear economy and make different choices in the use of raw materials. In a CE our waste streams are used as resource for other products. Right now a lot of plastics are produced for low-value uses, single use products such as plastic bags. InGarden considers the transition to a CE is really important. Rob Lefeber, co-owner of InGarden mentions he has lived in Vietnam and other Asian countries, there the waste problem is much worse than over here. In their plastic business in the

Netherlands it is their intrinsic motivation to reduce the amount of plastic waste and explore opportunities to do so.
InGarden manufactures street, garden and park furniture from recycled plastics and sells these products business to business, in the consumer market and to governments. A growing number of parties such as the Flemish government are choosing for plastic. In the tender of the Flemish government durability and sustainability are also considered. InGarden is confident there is a trend and that this trend will continue and the demand for recycled products will continue to grow. The motto of InGarden is “waste is produced here, so let's also reuse it here”. This local solution, whether it is in Almere or another municipality, is for InGarden their main motivation. Almere is keen to recycle locally with the goal to become waste-free and turn their plastic waste into raw material for products in the public space. InGarden wants to process their household plastics into products for the open space such as wall covering and scaffolding. InGarden thinks they have a chance with the combination of cheap location, cheap staff, efficient process and cheap raw materials. It is not their goal to become a millionaire with their business, they want their business to be cost-effective and get everything up and running. InGarden has an intrinsic motivation towards circular thinking, for them a sustainable product is a logical choice and it does not matter to them whether their margin is three, five or ten percent. However, if it is going to cost InGarden money they will stop soon, after all they are businessmen too (Lefeber, 2017).

InGarden is looking for support from the municipality to undertake business. Their choices as entrepreneurs are dependent on how well these choices are supported by the government. For example, when Almere states they want to stimulate plastic reuse, they should simply start to buy and use recycled plastic. This will make the market flourish so that entrepreneurs will enter the market. Currently the experience of InGarden is that it is actually a bit reversed, there is no incentive for entrepreneurs to step into local plastic waste value chain as most products for the municipality are still made of wood (Lefeber, 2017).

### *SNM*

#### *Expectation and visions*

InGarden has an intrinsic motivation towards the CE, sustainable products are the way to go. They expect when Almere will chose for plastic instead of wood, all other municipalities in Flevoland will follow. This would inject the plastic factory with life (Lefeber, 2017).

#### *Social networks*

InGarden has visited a number of factories such as Lankorst and Govaplast and discussed with those entrepreneurs which mistakes they made, where the risks are, which machines they have and which properties they have. InGarden realized many small bits make a lot of things, so they really need to pay attention to everything. Before InGarden will be able to start invoicing, as soon as they are in business, they are already a year further. Until that time they have pay for everything with their own money. Rabobank wants to invest in green projects in the Almere region. If Rabobank wants to have a plastic factory on their name, there will be different tariffs for InGarden than private investors will offer.
InGarden would in collaboration with, for example MEPPP, invest and run a pellet factory. In this scenario MEPPP will determine the quality of the grains. Flevoplast will advise on the use of the machines. A contractor, such as InGarden, will process the products. The municipality will pay for these products. And part of the personnel can be managed through the Tomin group (Lefeber, 2018).

The tender for the waterways in the provinces is shifting from the municipalities to the water boards. From that moment on the waterboards will be responsible for the waterways and their maintenance. This is an important shift for the companies active in the MPHW niche because the waterboards are a large customer. When the waterboards decide they do not want to use recycled plastics the

companies lose a lot of their market. However, this shift is also a huge chance because the waterboards are in charge of large areas and could be a large customer (Lefeber, 2017).

*Learning*

The people who are around the table now in Almere every time are actually the least interesting people. InGarden would rather sit around the table with people who want other things, that way they can find out their convictions and reasoning. InGarden is taking a risk by their investment and would be ashamed to waste this money. Therefore they need to feel good about the success of their business, at the moment cannot get a picture of the resistance within the municipality. Some officials at the municipality continue to make conventional choices, continue to cherish their own wisdom and continue to make their own decisions Until the day of today timber is still being used for wall covering in Almere, it is sure their choice is not for plastic yet (Lefeber, 2017).

Plastic companies in the niche do not compete against each other but rather compete together against wood. The more they can help each other out and make their business successful, the better they can compete against wood. Wood is so linear, if you put a wooden fence in the garden in your garden, it will be rotten after ten years. The moment you are successful as a plastics industry and you can withstand competition better, that is the moment the industry can grow, become bigger and consequently reduce prices. But the demand is lagging behind at the moment. By taking dirt cheap raw material from the municipality, an efficient production process, good partners, a good image and good advertising InGarden hopes they can eventually offer products for half the current price and make it interesting for the market (Lefeber, 2017).

### *Business model*

*Value proposition*

The value proposition of InGarden is the manufacturing of street, garden and park furniture from recycled waste plastics. Their custumer segment is broad and is from business to business, to the consumer market and to governments. One of their main customers is the Flemish government who prefers plastic over wood for their street furniture. A local solution to the plastic waste, whether it is in Almere or another municipality, is for InGarden their main motivation. Their products have a lifespan of 50 years minimum and are maintenance free. InGarden only uses secondary raw materials that otherwise would have been incinerated. Governments are the main clients of Ingarden. Therefore they are also in conversation with the municipality of Almere. In addition InGarden would prefer to be able to sell their products to the citizens, there are many houses on the water in Almere that could use these products (Lefeber, 2017).

*Value creation*

InGarden creates value by processing the household plastic waste of Almere into products for the open space, such as wall covering and scaffolding. Their products are made through extrusion of the waste plastics into molds. InGarden thinks they have a chance with the combination of cheap location, cheap staff, efficient process and cheap raw materials. Sustainable products, that is where the value for their customers is at. The municipality does have a network with other municipalities, which means that InGarden can eventually dispose their overproduction in those municipalities.
For a full-time continuous business InGarden will need ten people to be able to have one person full-time at location. When InGarden could work together with another actor they can share activities and labor. The Tomin Groep in Almere employs people with a distance to the labor market. Other startups are not as enthusiast about these possible employees because they think these people do not fit the job. For InGarden this depends on the scale of their business. If the scale is large enough and several people a day are needed, people from the Tomin group would be welcome. InGarden beliefs that the moment they can organize a kind of learn-work workplace and there is a professional manager present in the factory, the people from Tomin could be educated to work as an operator or warehouse clerk. They then only have to hire a strong manager as all the other staff can be employed

through this construction. When the government considers it important to subsidize this, the personnel costs of the factory could be relatively low (Lefeber, 2017).

*Value capture*

InGarden has visited a number of factories to discussed with those entrepreneurs which mistakes they made, what are the risks and which machines they have. A Chinese machine costs half the money as a German machine, but they have a lot more problems with support. InGarden will therefore first buy a German machine, which costs around 200.000 euro. When that one works well, a Chinese machine or a second-hand machine can be added.
InGarden will capture value by selling their products to the municipality. The cheaper InGarden can buy the plastics waste from the municipality, the cheaper they can sell the product back. This way the municipality benefits from offering the plastics for cheap. This way there will be a fixed sale price for the municipality. Additionally, when InGarden can sell ten to twenty percent if their production for the market price that is where they take their margin. InGarden prefers a lot of volume because labor is going to be a considerable part of their budget. InGarden eventually wants to process 15.000 tons a year (Lefeber, 2017).

### 5.3.4 MEPPP

MEPPP is a startup company located in Elst. Michel ten Bok is the founder of MEPPP, he is 75 percent shareholder and started the company because: “nothing is happening with our plastic waste and we cannot just throw everything in the incinerator” (Ten Bok, 2018). For Michel a CE is to use discarded material again. A CE is a must according to MEPPP.
Michel has worked at companies that make consumer products from plastics, so he is quite familiar with plastics. MEPPP has set its goal to replace wooden transport pallets with plastic transport pallets made from post-consumer plastic waste. At this moment they have patents on their products, their way of producing and the product that they want to market. In addition, they have the knowledge accumulated during processing pilots in Slovenia (Ten Bok, 2018).

MEPPP experienced that finding investments is hard for startups in the plastic waste niche. Banks like Triodos and ASN do not want to invest because there is too much risk. They state that “they are not crowdfunding or a risk capital bank, but just a bank”. Banks only act according to their own interests. The same applies for investors, investors want to know whether there are customers and a cash flow, without these they will not invest. For this reason it is important municipalities, such as Almere, start to invests in startups.
The goal for a company like MEPPP is to operate sustainably and to exist for 10 to 15 years, but foremost they have to be a profitable company. They need to have enough income to pay the costs. These recycling startups are plastics processing companies. They are not founded to ensure that disabled people come to work, that is not their business, that is something else. Companies like MEPPP are prepared to facilitate labor to people with a distance to the labor market, but that should not be the main goal. Almere wants to separate and sell the good plastics that are in the plastic waste, the valuable monostreams. The left over mixed plastics are meant for the startup companies. These mixed plastics are contaminated and MEPPP would need 70 euro per ton to process it. Right now, instead of paying money to MEPPP Almere wants to receive money from MEPPP for this mixed stream. In the present situation the transporting the plastic waste to the SUEZ waste plant costs Almere 120 euro per ton. So even by paying MEPPP 70 euro they already gain 50 euro. MEPPP wants to make transport pallets and the number of transport pallets they want to produce will exceed the plastic that is available in Almere. MEPPP therefore asked Almere whether they could receive more plastics from other municipalities such as Zeewolde and Amsterdam. However, this was not the intention of Almere. For their production MEPPP needs a certain quantity of waste plastics, when there is too little plastic at a given moment this would mean they have to close the factory (Ten Bok, 2018).

### *SNM*

#### *Expectations and visions*

The vision of MEPPP is to process the global plastic waste mountain into products. These products could be pallets, sheet piles, benches in the park, shelters. For the municipality of Almere this is their greatest need, MEPPP does not know how much hardwood the municipality buys per year to make scaffolding and wall covering . These can be made from plastic, then you keep the plastic circular in Almere and you do not need to use hardwood (Ten Bok, 2018).

An incentive for a startup could be to continue designing with Wageningen University or TNO or another research institute. But at a company like TNO they will state that everything the startup wants to do will be the IT rights of TNO. In such a scenario all the knowledge and expertise that is provided will be belong to the research institute, as a commercial company that is just not attractive (Ten Bok, 2018).

#### *Social networks*

MEPPP has done a lot of research for the municipality of Almere regarding possibilities for business cases. One study was into the quality of collected plastics in different districts in Almere. MEPPP wants four actors involved in their business. The most important thing is a customer, so they developed a product and are now looking for a customer. Next they need an independent agency to validate their practices and products, such as TNO. Third, MEPPP needs suppliers of waste plastics, right now they have a few Italian and a Slovenian suppliers. Italy offers a certain quality for a certain price, which is cheap, because in Italy the plastic waste problem is even bigger as their dumps are full and they have to do something with the plastics. Lastly MEPPP is looking for the polluter, they are diligently looking for a Unilever or a Jumbo, the parties that make plastic packaging or put products in it. MEPPP set as goal to ensure that products become circular. It has to go from: production, packaging, sales; towards: production, packaging, sales, recycling (Ten Bok, 2018).

The last actor MEPPP needs to involve is interesting as MEPPP notes that at the moment the packaging industry simply pays some money to fulfill their responsibilities so others can clean up their mess. The Waste Fund Packaging is led by those who are the actual polluters; the Albert Heijns, the Dirks, Jumbo's, they sit and have a nice meeting, but they do not come up with solutions. When that kind of men are in the Waste Fund Packaging you can expect they will not support kinds of projects like the one of MEPPP. It simply comes down to the same accounting every time, what costs something, what does the processing cost, in the end it has to be profitable otherwise it will not be done (Ten Bok, 2018).

#### *Learning*

MEPPP experienced the opportunity in Almere as a slowdown, it has cost them lot of energy and has delayed them. They felt Almere wants to be green and circular but their budget to reach these goals is none. Almere wants to facilitate a parcel in the Vijfhoek under certain conditions. One of these conditions is that they would like to have the startup company to hire people who have a distance to the labor market. Almere expects the problem of the municipality will be solved by entrepreneurs but they tend to forget that startups firstly need to earn money to exist. Therefore helping out the municipality in regard to social employment is a side issue and should only be discussed later in the process. When social employment is a main goal within the establishment of recycling plastics while involving market companies, the municipality is skinning business opportunities.
MEPPP has put a lot of research, time and money into possibilities for business cases within Almere. They also executed a study for the municipality of Almere where they measured the quality and composition of MPHW waste that was collected in different districts. There was a clear difference between the collected plastic in districts with flats, the center and the suburbs. In center, disposing waste costs more money, more waste is being dumped and more other waste is disposed in the plastic containers. However, in the suburbs, the plastic containers are mostly filled with plastics. At

least half of the Almere plastic waste was suitable for making plastic pallets so MEPPP liked to continue and let Almere know they wanted to build a production plant on the Vijfhoek. Therefore they also wanted to know the financial possibilities that the municipality would provide them. But Almere does not offer any possibilities for financing because interested startups first have to tender in Europe. The costs and paperwork involved with a tender are enormous and MEPPP refrained from these affairs. Within the collaboration of MEPPP and Almere the municipality wanted MEPPP to share their knowledge and expertise they already had gathered. MEPPP did not feel like giving this away. Circular does not mean to give things away for free. Naturally, the municipality must give something, carry a risk, even if it is only a finger, but MEPPP does not get a nail yet. MEPPP is convinced that when you do not get these matters settled in the beginning, then you should continue and be two years further, by then it will be a complete disaster (Ten Bok, 2018).

Every of the other startups look for cooperation with MEPPP because MEPPP have quite some knowledge and expertise. But MEPPP has their our own tool in mind and they are going to work towards that goal on their own and will not get distracted. They will certainly not start making benches for the municipality of Almere because that is not their expertise (Ten Bok, 2018).

### *Business model*

#### *Value proposition*

The value proposition of MEPPP are plastic transport pallets that will contain twenty-five kilos of waste plastics. In the future MEPPP will also look into other products. First they will make regranulate pellets from post-consumer plastics including mixed plastics. From these pellets they will be able to make transport pallets. With these transport pallets they want to market a plastic pool pallet that can compete with the price of wooden pool pallets such as Europallets. The customer segment of MEPPP are companies that want to replace their wooden pool pallets for plastic pallets (Ten Bok, 2018).

#### *Value creation*

MEPPP wants to create value by offering a transport pallet that is better, cheaper and more sustainable than the wooden transport pallets. They offer a plastic pallet where the total cost of ownership is more advantageous than a wooden pallet and are prepared to start the competition with wooden pool pallets. Their resource would be household waste plastics from municipalities such as Almere. From these plastics they make pellets that consist mostly of polyolefins, the most common polyolefins are polyethylene (PE) and polypropylene (PP), and are fit to produce modular transport pallets which will be extruded from the pellets. These modular transport pallets fit the International Organization for Standardization pallet norms (ISO 8611). Therefore the transport pallets of MEPPP don’t need adjustments and could replace wooden pallets (Ten Bok, 2018).

#### *Value capture*

MEPPP will capture value by a pallet pooling system where their customers pay for the use of the pallets, their customer will not own the pallet. In each of the pallets MEPPP will install a tracking and tracing device so that the customer knows at all times where their pallets and thus their goods are. The tracking of the pallets will demonstrate that the pallets of MEPPP last a lot longer than wooden pallets do, they expect their pallets to have a lifetime of 100 journeys. This is a tenfold in lifetime compared to wooden pallets with an average lifetime of ten journeys. Instead of paying three euros per journey for a wooden pallet, the customers of MEPPP will pay two fifty per trip. This will save their customers a lot of money in the long run. However, MEPPP still needs to find an investor to start production. Banks do not want to take the risk yet (Ten Bok, 2018).

## 5.4 BMI

The companies in the MPHW niche of Almere all have technological business model where they create value from waste. In their business model they use the plastic waste of Almere and want to recycle this into products again. The role the business models of Upp!, Save Plastics, InGarden and MEPPP play in the transition towards a more sustainable plastic household waste regime is as a device to commercialize technological niche innovation. Their business models are to promote the technical niche innovation where products are made from MPHW and to commercialize the new technology in the niche and make their business proof for the market.

## 5.5 Cross case analysis

### 5.5.1 SNM

#### *Expectations and visions*

UPP! expects an enormous demand for plastics the coming year, they want to save at least 250.000 tons of these plastics from incineration, landfills and oceans by the year of 2025. In Almere Upp! wants a factory that can process 5.000 tons a year and show it is possible to recycle the mixed plastics into products. When they have proven it is possible, they want to expand and have five different processing facilities in the Netherlands by 2023.
Save Plastics wants to save 2.500 tons of litter plastics a year through partnerships with municipalities. They want to become circular 2.0, that is the production of a proven product from local waste, combined with social employment.
InGarden wants to move towards a CE, sustainable products are the way to go. They expect as soon as Almere will chose waste plastics for their products other municipalities in Flevoland will follow their lead.
MEPPP wants to process the global plastic waste mountain into products. This could be a whole range of products. In Almere the hardwood that is now used for scaffolding and wall covering could be replaced by products made from local plastic waste.

#### *Social networks*

For Upp! their network is really important. They work together with two partner in Belgium: Govaplast and ECO-oH! In the network good communication between the actors in the waste recycling is key. As not only one product, such as wall covering , should be made from recycled plastics there should be market research. Municipalities, provinces and and companies have to be involved and think about what kind of products they really need and want to have. Upp! prefers to deal will local authorities because they want to close the circle locally. Many products can be made from the plastic waste and governments can play an important role in the acceleration of these recycling practices. Collaboration between different parties is essential, therefore Upp! also wants to involve universities, educational institutes, research institutes, governments, companies and citizens. Upp! wants to name their plastic factory the ‘Circular Plastic Experiment Center’ which not only a place for production but also a space for innovation and open for visitors.
Save Plastics note that the ambition of politics is very important and believe this ambition is there. They place themselves at right side of the transition from a linear economy to a CE, they see projects are about to fall. Save Plastics is part of the Plastic Fantastic cooperation. Plastic Fantastic is created as an initiative of multiple actors in the search for a solution to the waste plastic problem. Save Plastics always goes to the source of the plastic waste and does not work together with the large waste processors. At the moment actors that have the budget and are willing to invest are missing. A guarantee of Almere that they will invest half a million in the coming five years would for Save Plastics be enough to invest.
InGarden has visited a number of factories that process waste plastics to learn the do’s and don’ts. They need to pay everything before they start producing, this can cover a time period of a year,

therefore they need to be sure what they are doing. InGarden would like to invest and run a pellet factory in Almere in collaboration with MEPPP. Employees could be offered through the Tomin group.
MEPPP did research for Almere into possible business cases. MEPPP needs four kinds of actors involved into their business: a customer, an independent agency to check their products, suppliers of waste plastics, the polluter. They want to involve the polluters because at this moment they do not offer any solutions. It could also be interesting for a startup to involve a university of a research institute. However, these institutes will be the owner of the knowledge and expertise that is provided, this is not really attractive for a startup.

### *Learning*

Upp! has the idea that the municipality of Almere could offer them a lot more than they offer at the moment. Almere should be more specific and declare they want to buy circular products, for instance benches. Upp! wants to build their first Circular Plastic Experiment Center in Almere because they think the potential is huge. However, Almere requests all kinds of information from the start-ups because they can pose a risk. Other governments like the province of North-Holland would like to join as well as munipalites in the MRA. The experience UPP! is that the way Almere is tendering has been quite conventional. Focus should be on the recycling of plastics and not on the cheapest price per product. Upp! was relieved the price indicator was not included in the tender in the end.
Save Plastics has learned how things go at the official level in Almere. Only a few people in the municipality take the lead in the way towards a CE. Save Plastic has learned that provision of information is most important for them to be able to proceed, without this information projects end up on a stack. In the project of Almere they also learned that although there is the political ambition to realize the plastic factory, there are a lot of people involved. The municipality should do a pilot project to start. Save Plastics has been warned for the progress made with the municipality, it is two steps forward and one step back.
InGarden has talked with the municipality of Almere. The people that are around the table now are the least interesting people for them, InGarden wants to talk with the people in the municipality that want other things to learn their convictions and reasoning. They also learned some people at the municipality continue to make conventional choices and cherish their own wisdom. In the mixed plastics waste niche companies do not compete each other, instead they compete against wood together. However, the demand for their products is lagging behind. InGarden hopes that with cheap materials, efficient production, good partners and good advertising they can compete in the market.
MEPPP learned in Almere that they wasted a lot of energy and time. Almere wants to be circular and facilitate a space for start-ups but only under certain conditions. One of these conditions is that people with a distance to the labor market should be employed by MEPPP. A start-up first needs to make money before helping a municipality out with social employment, with this proposal Almere is skinning the business opportunities of MEPPP. MEPPP put a lot of research, time and money into possible business cases in Almere. In the pilot project of Almere two of the three districts had waste suitable for the products MEPPP wants to make. MEPPP wanted to start in Almere but Almere does not offer any finance options. Almere expected that MEPPP would share their knowledge and expertise, but MEPPP does not give this away for free. Because MEPPP and Almere could not settle these matters in the beginning MEPPP sees no reason to start a collaboration with the municipality and will keep working towards their goal on their own.

### *Shielding*

There exist shielding from all levels in the MLP. On the landscape level shielding comes from new legislation, on the EU and national level, regarding plastic products and the recycling of plastics. In the regime level this regulation is translated into practices of the waste processors and new sustainable goals the municipalities set for the future. In the case of Almere, the municipality offers a place where potential companies can develop. Thereby the niche is shielded because Almere wants to reduce their waste and to do so creates a space where companies are shielded for pressures from

the dominant plastic waste regime. This way companies in this space can pursue to develop and drive technological innovation by producing products from MPHW through extrusion molding, in the MPHW niche of Almere. Within this niche Almere will offer the companies a space and a guaranteed supply of raw materials together with a guaranteed purchase of produced goods

### *Nurturing*

The nurturing of the companies within the niche are the articulation expectations and visions, helping social network processes and the support in learning. The companies have their own expectations and visions, networks and learnings in the project in Almere. These are found in the previous section.

### *Empowering*

The empowering of the niche is a stadium the niche of MPHW in Almere still has to reach. The potential companies in the niche will first have to start doing business in Almere to become fit to enter the market and be competitive in the plastic waste regime. A successful development in the municipality will make other municipalities follow. This could open up a new market for the companies in the niche to recycle MPHW into products locally and change the present regime.

### *Conclusions*

It is clear that all four niche companies have a shared vision where they want to challenge the plastic waste problem by making products from the waste. How they want to do it is different. Upp! wants to have multiple factories in a couple of years and Save Plastics would like to save plastic litter in municipalities. The network is really important for Upp! and this is apparent in the actors they already involved and want to involve. Save Plastics has been around for a while and has a production partner as well as some larger clients they have projects running. InGarden would like to work together with MEPPP, however MEPPP has indicated they have no need for any collaboration. MEPPP experienced the potential project in Almere as waste of time and money. Upp! mentions they have the feeling Almere hold things back, Save Plastics mentions the process goes two steps forward and one step back, and InGarden would like to talk with the people in the municipality that are not yet in favor of the plastic factory. It can be concluded that the actors experience progress made with the municipality is slow, conventional, sometimes with the wrong people and for MEPPP as waste of time.

Table 5.1. SNM processes niche actors.

| | **Expectations and visions** | **Social networks** | **Learning** |
|---|---|---|---|
| **Upp!** | Enormous rise demand plastics, save 250.000 ton waste plastics by 2025, five factories by 2023 | Almere, Govaplast, ECO-oH!, municipalities, provinces, research and educational institutes | Almere could offer more options, tendering procedure is conventional |
| **Save Plastics** | Save 2.500 ton of litter plastics a year, circular 2.0: include social employment | Almere, Hahn, Diergaarde Blijdorp, Natuurmonumenten, Plastic Fantastic | The way things go at official level Almere, slow progress due to many people involved |
| **InGarden** | Move towards CE by producing sustainable products | Almere, MEPPP, Tomin | Talked with many people, need to talk with people that oppose plastic factory, |

| | | | |
|---|---|---|---|
| | | | demand for recycled products is lagging |
| **MEPPP** | Process global plastic waste mountain into a whole range of products | Almere | Wasted time and money in Almere, MEPPP not a place for social employment, no opportunities for financing from Almere |

### 5.5.2 Business models

#### *Value proposition*

Upp! wants to make a variety of products such as wall covering , scaffolding and furniture for in the public space. Their main customers are municipalities.
Save Plastics is a producer of all kinds of plastic products, most are used in the area of water such as shelving, scaffolding poles and planks, and collision protection. Their customers are local governments but also amusement and nature parks.
InGarden manufactures street, garden and park furniture, but also wall covering and scaffolding. Their customers are businesses, the consumer market and governments.
MEPPP wants to make transport pool pallets that can replace wooden pool pallets. Their customers are all companies that want to replace the wooden pallets for plastic pallets.

#### *Value creation*

Upp! wants to create value by locally recycling the plastic household waste of Almere. First they want a demo factory to show it is really possible. There they want to make a range of products that are made from low to high quality plastics, the quality of the regranulate that will be used will depend on the final product. Upp! will involve product developers, architects and designers in the products they are going to make. The MPHW will turned into products and thereby pollution and $CO_2$ will be stored. Upp! wants to include blockchain to give everyone transparent information on where their products are and what they contain.
Save Plastics creates value through product design and are at the moment becoming more product dependent. They are expanding their assortment and now also busy with cladding. Recently they started to give all their products a material passport. As sorting practices are improving the quality of the residual flow, the mixed plastics, is getting smaller and worse. For Save Plastics it is the challenge to improve their practices to be able to make products out of this flow. In new projects with Blijdorp zoo and Natuurmonumenten they will turn the waste plastics which they receive from these customers into products they can use in their parks. Save Plastics is also working on a lease model, but that is still a future.
InGarden creates value by turning household plastics into sustainable products for the open space. They think they can compete the market by a combination of cheap location, cheap staff, efficient process and cheap raw materials, all of which they can get in a collaboration with Almere.
MEPPP wants to create value by turning waste plastics into transport pallets. They want to make pool pallets that can compete with wooden pool pallets on their price per trip.

#### *Value capture*

Upp! will capture value by the recycling of household plastic waste and turn these into products that can be sold and used locally. Their costs to start the project is 100.000 to 200.000 euro for the machinery.
Save Plastics captures value by the delivery of products made from waste plastics. They think their water products have a lot of potential in Almere. The costs of Save Plastics are the purchasing of the

molds, processing of the raw materials, preparation of the raw materials, marketing, and their employees.
InGarden will capture value by selling products to the municipality, the cheaper they can get the waste plastics they need from the municipality the cheaper they can sell the products back. The surplus product they will sell on the market, this is where they will take their margin. The most costs will be the machinery which will cost around 200.000 euro.
MEPPP will capture value by a pallet pooling system where their customers will pay for the use of the pallets. They expect their pallets to last ten times as long as wooden pallets, this will save their customers a lot of money in the long run.

### *Conclusions*

It can be concluded by looking at the business models that Upp!, Save Plastics and InGarden are all active in the production of wall covering and scaffolding. InGarden and Upp! want to start doing business in Almere and recycle the household plastics locally into products. Save Plastics does not necessarily want to start producing in Almere as they have a partner in Germany. This is where Upp! and InGarden differ from Save Plastics in their value creation and value capture. Upp! and InGarden want to recycle the household plastics locally into products and that is where they create value whereas Save Plastics only captures their value by producing product from waste plastics, the local aspect is not of interest for them. MEPPP is entering a completely different product segment, they want to manufacture regranulate pellets and use these to produce plastic transport pallets. MEPPP wants to create value by setting up a plastic pool pallet system that would replace wooden pool pallets. In the business model of MEPPP the plastic household waste of Almere would be used for products that are used for global transport. However, the regranulate pellets MEPPP manufactures could be used for products used locally such as wall coffering and scaffolding.

Table 5.2. Business models niche actors

| | **Value proposition** | **Value creation** | **Value capture** |
|---|---|---|---|
| **Upp!** | Wall covering, scaffolding, furniture public space | Locally recycle household plastics, blockchain, involve developers, architects and designers | Recycle household plastics into products used locally |
| **Save Plastics** | Wall covering, scaffolding, collision protection | Product design, product passport, lease model | Delivery of products made from waste plastics |
| **InGarden** | Wall covering, scaffolding, furniture public space | Local sustainable products from household plastics | Recycle household plastics into products for the municipality |
| **MEPPP** | Pellets, transport pallets | Pellets and transport pallets from waste plastics | Pallet pool system for recycled plastic pallets |

# 6. Discussion and conclusions

## 6.1 Discussion

### 6.1.1 Limitations

Interviews with the actors in the niche and municipality of Almere were semi-structured interviews to give more room for in depth questions. Time in the interviews was needed to gather information regarding SNM processes and business models of the niche companies. In the interviews there was not always made a clear difference between the MPHW niche and the MPHW niche in Almere. This may have influenced the answers regarding SNM processes within the niche in Almere. More specific questions targeted at the processes and state of affairs within the pilot in Almere could have provided a more detailed picture of developments within the local niche. Because I was an intern at Royal HaskoningDHV at the time of the interviews and in close connection with the Almere municipal cleaning, this may have been of effect on the openness of answers of the interviewees.

At the landscape level macro trends that are of influence on the regime and consequently on the niche are shortly set out. On the regime level a number of actors are present in the plastic waste processing infrastructure, such as the Dutch government, the MPHW processors, municipalities, the Waste Fund Packaging and Nedvang. This study is unable to encompass the regime and regime actors in the plastic waste value chain. From these regime actors there only have been interviews with Nedvang and the municipality of Almere. The presentation of the regime in this research is therefore foremost on the basis of the interviews with niche actors and the municipality of Almere.

The niche developments in Almere are still in early stages, this limits the value of the developments in a greater perspective as the MPHW niche in Almere still needs to take shape. The MPHW niche in the Netherlands is beyond the scope of this study. Only companies in the local MPHW niche in Almere are involved in this study, therefore the findings of this study are not representative for the entire MPHW niche.

### 6.1.2 Interpretation of the results

The MPHW niche in Almere is analyzed through the internal niche processes that take place within the development of a niche and BMI. With the analysis of this local niche it was assumed that the processes within the niche of Almere could be translated to developments within the levels of the MLP. However, the niche in Almere is still in its infancy and is only one local technical project, therefore the findings of the case study are limited to Almere. The project in Almere started because of local reasoning within a local network: the municipality of Almere, Almere Resource Collective and the Vijfhoek. The developments in Almere are the developments of a local technical project and not of the niche. The MPHW niche level in the Netherlands is constructed by multiple of these local projects, such as in Almere. These projects will lead to learning trajectories and eventually assist in the successful realization of other projects in a niche were a set of cognitive, formal and normative rules exist.
However, the developments in Almere are influenced by development on the landscape and regime level. Without these developments niche innovations are hardly successful. Of course, statements can be made about expectations that are based on developments in Almere, these are included in the broader relevance of the findings in this study.

### 6.1.3 Theoretical reflection

In the research framework, it was considered to create different regime levels in the MLP. This was considered because there exists a separation between (1) the large waste processors and the covenant concluded by the packaging industry and the Dutch state in the packaging covenant and (2) the municipalities in the Netherlands, which Almere is part of. The first are the processors that process the waste, the producers and the affiliated organizations responsible for financing the

processing. The second are the municipalities, municipalities that set goals for sustainability and decide how they collect waste and have it processed.

Because niche companies are subjects of this research it seemed necessary to involve their business models and therefore BMI. It was expected that the business models of the companies in the niche are essential for the analysis of the developments of the niche and companies. Business models explain a lot about the companies and their motives, their value proposition, creation and capture. However, although the business models are good to map the values of the niche companies proved not to be of great value for the analysis of developments within the local niche. In this case, the niche companies are active in the same line of work, use the same technique of extrusion molding and the same resources, therefore their business models are quite alike. Their business models where not necessary to analyze the developments of the MHPW niche in Almere based on the SNM processes. Business model can play a more important role when it acts as a non-technological niche innovation. Some of the niche companies want to create business models, such as a lease model for the products they make. Within this perspective the role business models can play in the developments of the MPHW niche would increase.

SNM is about the processes between the actors in the niche, niche companies are thereby perceived as actors as is the municipality of Almere as initiator of the local niche. The processes of the SNM were not sufficient to map all developments, business models of the companies where required to get insight in their business values, these values are not covered by the SNM processes. To involve business models BMI is included in the framework. BMI does cover the values of the business models and the role they can in the MLP but it puts BMI above technological niche innovation. In the case of the local MPHW niche in Almere business models act as device to commercialize technological niche innovation but do not stand above the technological niche innovation of extrusion molding mixed plastic waste. Because Almere plays a role where the business model of the companies is a given business model with a guaranteed supply and demand from the municipality, BMI is joint with technological niche innovation.

### 6.1.4 Broader relevance

Almere wants to start a pilot project in MPHW recycling and other municipalities in Flevoland are also interested to join. It is therefore good to get to know the goals and developments of these municipalities and see where these can support the MPHW niche in Almere and the MPHW niche in the Netherlands.

In the analysis of the plastic waste regime it becomes clear that there exists a distance between producers of plastic packaging and the waste processors that process these same plastics after their disposal. There is of course the covenant with the producer responsibility, but this agreement does achieve the desired result. The desired result should be that the producers of packaging would improve their designs to make their recycling easier and that the waste processors would improve their standards. However, the separation of the plastic waste processors does not improve and they hardly perform better than the agreed DKR standards. The covenant is an agreement between the government and the producers of plastic packaging. The processors are not affiliated with the agreement or the producers, the only thing that connects them is the DKR standards they have to meet to receive their money. An essential link is missing where the producing parties are responsible for the life cycle of the products they produce, at present they do not take their responsibility in making plastic packaging more sustainable. They are allowed by the Dutch state to take their responsibility through setting up the Waste Fund Packaging, Nedvang and the Packaging Knowledge Institute. These organizations are funded by the packaging producers as agreed in the covenant. The remarkable thing about these organizations is that they are led by the packaging industry but operate as independent organizations with little cooperation or feedback to the producers where the plastic packaging are designed and made. To achieve a good recycling system for packaging plastics

this link between the design and production of packaging and the re-use and recycling of these packaging is essential.

The new hybrid management model gives municipalities such as Almere the opportunity to arrange their own waste management and receive the corresponding compensations. At the moment most municipalities are bound by contracts for the collection and processing of their household waste. But when these contracts expire they can take control of the processing and marketing of the packaging plastics themselves. Because municipalities are given more say in the processing of the waste, they will at the same time also have more influence on the processes in the plastic waste value chain. This will also change the dynamics within the plastic waste regime. Municipalities that pursue sustainable goals want to improve the standards of processing waste plastics and will try to do so. If this is the case, this will lead to a rise in the standards that the large waste processors now adhere to. It will also increase the pressure to extend the packaging producers responsibility, in that case a change in the packaging covenant seems inevitable.

Leaving the recycling of plastic packaging to the market through the packaging covenant has not provided in the right incentive for improvement. Not on the producing side and not on the processing side. When the Dutch government really wants to something about the plastic waste standards for the recycling of these plastics should be imposed by the state. To make recycling more attractive the demand for recycled plastics has to be stimulated. This demand will grow when, for example, more taxes are levied on plastics obtained from primary raw materials or when products must consist of a certain percentage of recycled plastic.

The companies active in the MPHW niche respond to the problem insufficient recycling of MPHW and the abundance of these worthless mixed plastics. These companies see opportunities to use the household plastic waste. The recycling of these worthless plastics is necessary, but these companies still receive little support to convert MPHW into products. Large processors in Germany are able to process MPHW into products such as wall covering and scaffolding, but in the Netherlands we could do so too and Almere could be the first.
The question that remains is how long the business case for extrusion molding MPHW will stand. At present, mixed plastics are still worthless and accumulating, so it's not a strange choice to store these plastics in products for the time being. Moreover, these recycled plastics products are usually substitutes for wood. With business as usual it can be expected that the proportion of mixed plastics relative to household waste will remain substantial. Only when separation is improved and the processing standards are adjusted the flow of MPHW will decrease; his will affect the business case of the niche companies using MPHW. However, the amount of mixed plastics in Europe is so great that scarcity is still far away. Chemical recycling may ultimately offer a way out for the processing of these plastics, but this will also take time. For now it's important to have producers of plastic packaging take responsibility to ensure that the recycling of packaging plastics meets higher standards.

### 6.1.5 Recommendations

In this research most attention was on the companies in the MPHW niche that had potential to be involved in the local MPHW recycling project in Almere. As this local project is only one of the trajectories that hopefully will construct a MPHW niche it would be of value to take the research to a national level. When more local projects in the Netherlands are involved a better picture can be formed of the developments taking place in the national MPHW niche. When there is a picture of the developments in the national niche statements can be made about the developments in the niche in relation to the regime and landscape according to the MLP. It is therefore recommended to involve several local MPHW projects in follow-up research. Once there is a better picture of the MPHW niche in the Netherlands it will be of value to include the plastic waste regime and its actors. This way both the influences from the regime on the niche and from the niche on the regime can be visualized. This

information is of value to the niche for nurture, shielding and empowering processes that can stimulate niche developments and prepare it for competition on the market.

## 6.2 Conclusion

To answer the research question the subquestions will first be answered.

*A - What are the main developments within the plastic household waste value chain in the Netherlands?*

On the landscape level the EU member states recognize that they need accelerate the recycling of plastics. Policies regarding waste plastics and the recycling of plastics are in the make on EU level and will be binding for the member states.

The current state of affairs in the Dutch plastic household waste regime is set by the packaging covenant and the three plastic household waste processors: Attero, Omrin and Suez. The majority of household plastics waste consists of packaging plastics. The packaging covenant is an agreement, between the Dutch government and the producers of packaging, to stimulate the recycling of packaging plastics. In this agreement producers have an extended producer responsibility for the waste of the packaging they have produced. To fulfill this responsibility the producers created three organizations: the Waste Fund Packaging, Nedvang, and the Institute for Sustainable Packaging. These organizations are responsible for the collection and recycling of packaging waste and its improvement as well as for innovations in more sustainable packaging. The producers pay, through these three organizations, for the collection, processing and marketing of the plastic household packaging waste. The processing of these waste plastics have to meet certain standards, the DKR-standards, that are set for each of the different kinds of plastics and for the mixed plastics. Because municipalities can decide how they manage their household waste there exist different collection systems in the Netherlands. The biggest difference in municipal waste management exists between pre-separation of plastic waste at household level and post-separation of the plastic waste at the waste processor. It becomes clear that large cities collect considerably less plastics, this is a problem because it is precisely the large cities where most people live. In these cities there is still much room for improvement.

There are little developments in the plastic household waste value chain by regime actors such as the processors. The packaging covenant does not encourage them to improve or innovate as long as they achieve the DKR standards. As long as the standards are not adjusted few changes are expected to occur at the processors. But other things do change, Nedvang introduced a new hybrid model for municipalities which allows them to arrange their own waste recycling. Within this model municipalities are also entitled to the compensations from the Waste Fund Packaging when they meet the DKR standards which are agreed on in the packaging covenant. This provides scope for municipalities, such as Almere, to recycle the waste more locally.

Other promising developments exist within the chemical recycling of plastics. This kind of recycling could turn plastics into naphtha and fuel again. This will have a major effect on recycling waste plastics. However, chemical recycling of plastics currently entails high investment costs and the projects that are in place are still in the design and testing phase. It will take a while before this method of recycling has enough capacity and an economical basis.

*B - What are promising innovations in mixed plastic household waste recycling in the Netherlands?*

There are multiple innovations in MHPW recycling in the Netherlands. These come from companies active in various fields, such as: technology for separating the plastics, technology to measure the

composition of the mixed plastics, technology to chemically recycle the plastics, and the making of products from the mixed plastics. The first three are technology providers, the last are the companies that actually produce products from the plastics waste. Then there are also municipalities, such as Almere, that take an active role in stimulating the recycling of mixed plastics.

Technology providers that are present in the MPHW recycling are promising. Recycling Avenue is a company that specializes in separation technologies for the recovery of plastics. Polytential developed the 'Virtual Chemist 'a tool to analyze the composition of the plastic waste with sensors. With this information, about the composition of the mixed plastics and the contaminants, it can determine for what purpose the plastic can best be used. BlueAlp developed a pyrolysis installation which can convert the mixed plastics into 70 to 80 percent fuel, under the best conditions. Their focus is now on converting the plastics into to naphtha again, naphtha can be used for plastics again but also in the chemical industry.

The companies that are on the producing side in the MPHW recycling melt the mixed plastics into products by means of extrusion molding. Companies range in their products from wall covering and scaffolding to outdoor furniture to transport pallets. The business models of Upp!, Save Plastics and InGarden are targeted at the recycling of MPHW into wall covering, scaffolding, outdoor furniture and collision protection. Save Plastics prefers to keep their production in Germany with Hahn and process the waste from Almere there. InGarden wants to set up business in Almere. Upp! also wants to have their production in Almere but want to combine this with a learning center for research and for visitors. In this learning center they want to collaborate with colleges and universities and give people the opportunity to see what actually happens with their plastic waste after disposal. MEPPP does something else, they want to make transport pallets and market these through a pallet pool system. To make these pallets they need a certain quality of recycled plastics, to reach this quality they want a factory that will produce different grades of pellets from the waste plastics. The grade of the pellets will determine for which product they can be used. The lower grades of pellets could eventually be used for the products that Upp!, Save Plastics and InGarden produce.
The producing companies have in common that they see MPHW as an resource and opportunity to make products, products that can also be recycled again. They indicated that they experience a rise plastic waste and want to save the value of waste plastics by turning these into products again. These products can consequently serve as storage for mixed plastics, and new technology can turn these plastics back into resources again in the future. Save Plastics and InGarden already make products from waste plastics. Upp! and MEPPP still have to start producing and are looking for a place to do so.

Municipalities set their sustainability goals, the current waste processing standards are not sufficient and municipalities want to do better. Because municipalities, such as Almere, indicated that they want to be able to start recycling their household packaging waste value chain themselves, Nedvang has taken this into account. The new hybrid model with the corresponding compensations is of great importance for municipalities in order to make the local recycling of MPHW economically feasible. This new possibility give municipalities the choice to take on the processing themselves and terminate their contracts with the waste processors. When this happens this will push large processors for better standards as they lose their market share. This way municipalities can play an important role in the innovation of recycling MPHW. Almere is not the only municipality to do so, other municipalities also encourage initiatives to combat the MPHW. However, Almere is one of the first municipalities to take a leading role in the development of the MPHW niche, top-down. Almere wants to set up a local MPHW value chain with the aim of bringing the waste plastics back to products locally and recover their value again.

*C - How can Almere facilitate and stimulate the recycling of mixed plastic household waste?*

The municipality of Almere has taken the initiative to initiate a local MPHW waste value chain. Thereby it has taken a leading role in the creation of a space where MPHW from Almere can be turned into products again. To attract these companies Almere needs to create certainty for investors, this is achieved by a guarantee of the municipality. In this guarantee Almere offers municipal plastic waste and will buy a certain amount of the products that are made from these plastics for at least a period of five years. In addition, Almere will support with the process, location, permits and possible subsidization. The local MPHW niche still has yet to take shape and Almere will first start with a pilot project.

Upp!, Save Plastics, InGarden and MEPPP experienced that that processes are slow, conventional and sometimes with the wrong people in their meetings with the municipality of Almere. Upp!, Save Plastics and InGarden have have registered for the tender and competed until the end. MEPPP left the process earlier because they felt that Almere did not offer them any support to really realize their plans. The municipality of Almere eventually decided to work with Save Plastics. Save Plastics was not keen to set up a production in Almere, so this choice did not seem obvious. Almere and Save Plastics now entered the third phase of the innovation partnership and will be carrying out some pilots this year. In addition, they are working on an EU Interreg application in which they try to arrange a million grant.

Successful development of a local MPHW niche in Almere can change the way household plastics are recycled. If successful, this will be an incentive for other municipalities to follow up, or for municipalities in Flevoland or the MRA to join the initiative of Almere. Municipalities that set sustainability goals can cooperate and realize a place where higher standards of recycling household packaging plastics and consequently mixed plastics achieved. Almere already took a leading role and will have to continue to do so in order bring this local niche to a higher level. Within this leading role it is important to involve technology providers active in the recycling of MPHW such as Recycling Avenue and Polytential into the process as well as the can help each other.
There exist a relationship between grade and recovery in the recycling of mixed plastics. Almere set the goal to reach a relation between grade and recovery based the environment which is still economically feasible. Almere would encourage the recycling of mixed plastics by demanding that the plastics will be recycled according to their value. These values would materialize into various grades of pellets. This has been taken into account in the proposal of MEPPP where different grades of pellets will be made from the waste plastics. The ‘Virtual Chemist’ from Polytential can help to measure the composition of the plastic waste and determine for which application the plastics can best be used. Different grades in the quality of the pellets will affect the types of products can subsequently be made from the pellets. The lowest quality pellets can be used to make wall covering and scaffolding and the higher quality pellets can be used for transport pallets and street furniture.

Save Plastics is a save choice for Almere as they already have experience and have a production partner in Germany. However, Save Plastic does not intend to build an entire factory in Almere and, furthermore, does not intend to separate the plastics into different pellets according to quality. The choice of Almere therefore appears to be a choice for certainty in which the goal of a local, progressive value chain for recycling mixed plastics may seem to have been forgotten. It is still a pilot project, so another choice can always be considered. A choice that is more locally oriented and offers the possibility of producing higher-value products.

With an answer to the subquestions the research question can be answered:

*What are opportunities to stimulate the niche of mixed plastic household waste recycling, in the municipality of Almere, and how can this be organized?*

On the landscape level forces are in place that push for more legislation regarding waste plastics and their recycling in EU member states. The lack of action in the plastic waste regime has pushed action taken by municipalities asking for more responsibilities in the recycling of household waste plastics. Nedvang introduced a new hybrid model which allows municipalities to arrange their own recycling systems and receive corresponding compensations from the Waste Fund Packaging. This is a major change in the course of events in the processing of MPHW.

Almere can stimulate developments of the local MPHW niche by involving and connecting companies that are active in the recycling of MPHW into their project. These different companies are active in technology for separating the plastics, technology to measure the composition of the mixed plastics, technology to chemically recycle the plastics and in making products from the MPHW. Technology providers can provide in technique to improve the separation of plastics and to determine the composition of the plastic waste. This way the plastics can be arranged on their use value.
Companies that are of real importance for the development of the MPHW niche are the ones that make products from the mixed waste plastics. These companies make products that range from wall covering to transport pallets through the technique of extrusion molding. These companies see an opportunity in using the MPHW as resource for their products and at the same time reduce the amount of plastic waste. The products they make can be substitutes for wooden products and can serve as a temporary resource bank for the now worthless MPHW.
Municipalities such as Almere can lead these companies towards a common goal and create the right conditions for development. Almere does this by means of a guaranteed supply of plastic waste and in addition a guaranteed purchase of products made from these plastics. They also offer a location for production and help in applying for subsidies. With these conditions, Almere has made it attractive for companies within the recycling of MPHW to develop business cases.

Almere can be the precursor of many when the niche develops successfully. For successful development, it must be considered why the project in Almere was initially set up. That is the shortcoming of the large waste processors in the relationship between grade and recovery of the MPHW. The goal must therefore be to make this relationship as sustainable as possible. At present, the most sustainable option seems to be to separate the MPHW by quality. As a result, different pellets of higher and lower quality can be made that can consequently be used for a range of lower and higher quality products. This requirement regarding the grade and recovery of the MPHW should therefore be included in the tender of the municipality, so that the companies will include them in their business case. A lot gains are still to be made in de MPHW niche, more interaction between the companies within the niche could stimulate its development.

## 6.3 Recommendations

The findings of these research are topics for further research into the recycling of household plastic waste. Recommendations are made for further research.

The municipality of Almere has taken the initiative to initiate local plastic waste recycling. For successful development this waste value chain a certain amount of waste is needed. Almere should therefore check with other municipalities whether they want to participate.

With new regulations in the make on the EU level, extended producer responsibility will apply for a larger range of plastic products. Therefore more national laws and regulations regarding the production and recycling of plastic products are needed and the packaging covenant will need to be revised or replaced. The extended producer responsibility has proven to be a difficult responsibility and did not lead to the desired results in the recycling of packaging plastics. In matter of fact, responsibility is not taken by the industry but is demanded by pressure from society and politics

toward sustainable practices. The point of departure should be that the polluter, so the industry, pays. The role the government has to play is not clear, although the packaging agreement does not seem to be the best approach based on its results. The Ministry of Infrastructure and Water Management (MIWM) should evaluate the results of the packaging covenant and compare it with the desired result of the covenant. MIWM has to research in which ways the producing side and processing side will be driven improve their standards in the design of packaging and consequently their recycling.

Another way to stimulate the recycling of waste plastics is to stimulate the demand for these plastics. At present the plastic recycling capacity in the Netherlands, for both mono-plastics and mixed plastics, is by no means large enough to process the Dutch household plastic waste. By stimulating the demand for recycled plastics it become more attractive to recycle them. This can be achieved, for example, by levying a higher tax on primary raw materials and by requiring products to contain a percentage of secondary raw materials. It is another task for the MIWM to research in which ways this can be achieved by legislation and regulations.

The waste processors Omrin, Attero and SUEZ have the infrastructure to process the plastic household waste according to the current he DKR standards. They get paid by municipalities to separate the plastic household waste. The mono-plastics have value and are sold by the processors. Waste processors compete each other to process as much plastic waste from municipalities as possible. in addition, it is important to find out what the future developments of the waste processors are. They are not doing much better than the DKR standards, but perhaps this is also because they are in fierce competition with each other and have no capital at all to innovate. At present the Waste Fund packaging is responsible for the recycling of the plastic packaging, they should research the market conditions of the waste processors and their drivers for innovation.

There exist number of different kinds of plastics but within these kinds (HDPE, LDPE, PP, PET) each of the plastics have numerous different compositions again which are used for packaging. This enormous amount of different compositions is not conducive for the recycling of these plastics. It seems logical to limit the number of compositions for each kind of plastics to increase their recycle possibilities and thereby the quality of recycling. It is important to research this for the MIWM to get an overview of all different kinds of compositions and also for legislation limiting the amount of possible compositions.

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## Appendix A – EU Directives

There exist multiple European Union directives regarding plastic products. The directives that are of influence on the waste management of household plastic waste are summarized in the following section.

### Directive 94/62/EC on packaging and packaging waste

This directive has the aim to harmonize national measures regarding the management of packaging and packaging waste in order to prevent any impacts on the environment of all member states as well as third countries or to reduce such impacts, thus providing a high level of environmental protection while on the same time ensuring the functioning of the internal market. 'Packaging' is defined as all products made of any materials of any nature to be used for the containment, protection, handling, delivery, and presentation of goods, from raw materials to processed goods, from the producer to the user or the consumer. 'Non-returnable' items used for the same purposes shall also be considered to constitute packaging.

Scope

This directive covers all packaging placed on the market in the EU and all waste stemming from packaging, whether it's used or released at industrial, commercial, office, shop, service, household or any other level and regardless of the material used.

Prevention

All member states shall ensure that measures to prevent to formation of packaging waste are taken. Such measures may consist of national programs such as projects to introduce producer responsibility to minimize the environmental impact of packaging. Member states have to take measures to achieve a sustained reduction in the consumption of lightweight plastic carries bags. Member states may encourage re-use systems of packaging that can be re-used in an environmentally sound manner.

Recovery and recycling

In order to comply with the aim of this directive, member states have to take the necessary measures to attain the following targets covering the whole of their territory:

a) no later than 30 June 2001 50 % as minimum and 65 % as a maximum by weight of plastic packaging will be recovered or incinerated at waste incineration plants with energy recovery;
b) no later than 31 December 2008 60 % as a minimum by weight of packaging waste will be recovered or incinerated at waste incineration plants with energy recovery;
c) no later than 30 June 2001 between 25 % as a minimum and 45 % as a maximum by weight of the totality of packaging materials contained in packaging waste will be recycled with a minimum of 15 % by weight for each packaging material;
d) no later than 31 December 2008 between 55 % as a minimum and 80 % as a maximum by weight of packaging waste will be recycled;
e) no later than 31 December 2008 the following minimum recycling targets for materials contained in packaging waste will be attained:
    i. 60 % by weight for glass;
    ii. 60 % by weight for paper and cardboard;
    iii. 50 % by weight for metals;
    iv. 22,5 % by weight for plastics, counting exclusively material that is recycled back into plastics;
    v. 15 % by weight for wood.

### Directive 2012/19/EU on waste electrical and electronic equipment

This directive provides measures to protect the environment and human health by preventing or reducing the adverse impacts of waste, from electrical and electronic equipment (WEEE), generation and management and by reducing overall impacts of resource use and improving efficiency of this use. 'Electrical and electronic equipment' (EEE) means equipment that is dependent on electric

currents or electromagnetic fields in order to work properly and equipment for generation, transfer and measurement of such fields and designed for use with a voltage rating not exceeding 1.000 volts for alternating currents and 1.500 volts for direct current.

Product design

Member states shall encourage cooperation between producers and recyclers and measures that promote the design and production of EEE, especially within the view of facilitating the re-use, dismantling and recovery of WEEE, its components and materials. Member states should take suitable measures to ensure that eco-design requirements facilitating re-use and treatment of WEEE, established in the framework of Directive 2009/125/EC, are applied so that producers to not obstruct, through specific design features or manufacturing processes, WEEE from being reused. Exemptions can only be made when specific design features or manufacturing processes present overriding advantages regarding protection of the environment and/or safety requirements.

Separate collection

All member states have to adopt measures to minimize the disposal of WEEE in the form of unsorted municipal waste to make sure the collected WEEE is treated correctly. Moreover the separate collection of WEEE is a priority because some of EEE contains ozone-depleting substances and fluorinated greenhouse gases.

For WEEE originating from private households, member states have to ensure that:

a) systems are set up that allow final holders and distributors to return WEEE free of charge. The availability and accessibility of necessary collection facilities, taking into account the population density, should be ensured;
b) when new products are supplied, distributors are responsible for ensuring WEEE can be returned free of charge to the distributor on a one-to-one basis as long as the EEE is equivalent. States may derogate from this provision as long as they ensure that it's not made more difficult for the final holder of EEE to return WEEE for free;
c) distributors have to provide for the collection of WEEE, at retail shops (400 $m^2$ or more) or in their nearby proximity, of very small WEEE (no external dimension more than 25 cm) free of charge and without obligation to buy EEE of equivalent type;
d) producers are free to set up and operate individual and/or collective WEEE take-back systems from private households as long as they are in line with the objectives of this directive;
e) regarding national and Union health and safety standards, WEEE that presents health and safety risks because of contamination may be refused for returning under points a, b, and c. For this contaminated WEEE member states have to make specific arrangements.

Member states are allowed to designate the operators that are allowed to collect WEEE from private households. Furthermore, member states may require that the collected WEEE has to be handed over to third parties that are acting on their behalf or that the WEEE is handed over for purposes of preparing for re-use, to designated establishments or undertakings.

For the WEEE other than WEEE from private households member states have to ensure that producers or third parties acting on their behalf are providing for the collection of WEEE.

Collection rate

All member states shall ensure the implementation of the 'producer responsibility' principle and that on that principle a minimum annual collection rate is achieved. From the year 2016 the minimum collection rate of WEEE is set for 45 % calculated on the basis of the total weight of WEEE collected in that year, expressed as an percentage of the average weight of EEE placed on the market in the three preceding years, in that member state. Member states should make sure that this rate evolves gradually in the years from 2016 to 2019, the minimum collection rate to achieve in 2019 is set on 65 % of the average weight of EEE placed on the market in the three preceding years.

In order to check whether minimum collection rates are achieved, member states have to ensure that information regarding WEEE that is separately collected is shared with all member states free of charge. At least this information should include information on WEEE that has been:

a) received by collection and treatment facilities;
b) received by distributors;
c) separately collected by producers or third parties acting on their behalf.

Some member states are allowed to have a lower WEEE collection rate because of their lack of necessary infrastructure, this does not account for the Netherlands.

## Directive 2008/98/EC on waste

This directive provides in measures to protect the environment and human health by preventing or reducing the adverse impacts of waste generation and management and by reducing overall impacts of resource use and improving efficiency of this use. 'Waste' means any substance or object which the holder discards or intends or is required to discard.

Waste hierarchy

In this directive of the European Parliament and of the Council the following waste hierarchy the following as a priority order in waste prevention and management legislation and policy is set:

a) prevention;
b) preparing for re-use;
c) recycling;
d) other recovery, e.g. energy recovery; and
e) disposal.

EU member states shall take measures according to this waste hierarchy encouraging the options that deliver the best overall environmental outcome. This may require different waste management approaches for different streams.

Member states shall ensure that their development of waste legislation and policy is a fully transparent process. Existing national rules regarding the consultation and involvement of citizens and stakeholders should be taken into account. Furthermore member states should include environmental protection principles of precaution and sustainability, technical feasibility and economic viability, protection of resources as well as the overall environment, human health, and economic and social impacts.

By-products

A by-product is defined as a substance or object, resulting from a production process and where the primary aim is not the production of that substance or object, may be regarded as not being waste but as being a by-product only if the following conditions are met:

a) further use of the substance or object is certain;
b) the substance or object can be used directly without any further processing other than normal industrial practice;
c) the substance or object is produced as an integral part of a production process; and
d) further use is lawful, i.e. the substance or object fulfils all relevant product, environmental and health protection requirements for the specific use and will not lead to overall adverse environmental or human health impacts.

End-of-waste status

A certain substance or object considered as waste shall cease to be waste after it has undergone a recovery, including recycling, operation in accordance with a set of criteria to be developed in compliance with the following conditions:

a) the substance or object is commonly used for specific purposes;
b) a market or demand exists for such a substance or object;
c) the substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products; and
d) the use of the substance or object will not lead to overall adverse environmental or human health impact.

Extended producer responsibility

To strengthen the re-use, prevention, recycling and other recovery of waste, member states may take legislative or non-legislative measures to ensure that any natural or legal person who professionally develops, manufactures, processes, treats, sells or imports products has extended producer responsibility.
These measures could include acceptance of returned products and of the waste that remains after the products have been used together with the subsequent management of the waste and financial support for these activities. Information regarding to which extent the product is re-usable and recyclable could also be provided to the public.
Member states may as well take measures to encourage taking the environmental impact, generation of waste and subsequent the use of a product into account within the design of a product. These measures could boost, inter alia, the development, production and marketing of products that are suitable for multiple uses, technically durable and are after becoming waste suitable for proper and safe recovery and environmentally compatible disposal.
Applying the extended producer responsibility member states should take technical- and economic feasibility and the overall environmental, human health, and social impacts into account to make sure the internal market keeps functioning.

Recovery

Member states have to take the needed measures to ensure that waste undergoes recovery operations according to the waste hierarchy. Where necessary to facilitate or improve the recovery of waste, waste should be collected separately if technically, environmentally and economically practicable and should not be mixed with other waste or materials that have different properties.

Re-use and recycling

Member states shall take measures to promote the re-use of products and prepare for the re-use activities by encouraging the establishment of re-use and repair networks, the use of economic instruments, procurement criteria, quantitative objectives or other measures.
High-quality recycling should be promoted by the member states and they have to set up separate collection of waste where technically, environmentally and economically practicable and appropriate to meet the necessary quality standards for the relevant recycling sectors. By 2015 each of the member states should have a separate collection for paper, metal, plastic and glass.
In order to comply with this directive and set up a European recycling society with high resource efficiency, member states have to take the necessary measures to meet the following targets:

a) by 2020, the preparing for re-use and recycling of waste materials such as paper, metal, plastic and glass form households and possibly other origins that are similar to households should be increased to minimum of overall 50% by weigth;
b) by 2020, the preparing for re-use, recycling and other material recovery of non-hazardous construction and demolition waste (excluding naturally occurring material) shall be increased to a minimum of 70% by weight.

Disposal

Member states have to make sure that where recovery is not undertaken, the waste undergoes safe disposal operations that meet the provisions on the protection of human health and the environment.

Protection of human health and the environment

Member states should ensure that waste management is performed without any adverse effects on human health, without harming the environment and in particular:

a) without risk to water, air, soil, plants or animals;
b) without causing a nuisance through noise or odors; and
c) without adversely affecting the countryside or places of special interests.

Costs

According to the polluter-pays principle, the costs of waste management should be covered by the original waste producer or by the current or precious waste holders. Member states are free to

decide that the costs of waste management are to be covered partly of wholly by the producer of the product from which the waste came and that distributors of this product may share in these costs.

## Appendix B – DKR requirements

There exist different product specifications for the different streams of plastic waste. In this appendix the different streams and their DKR requirements can be found.

Deutsche Gesellschaft für Kreislaufwirtschaft und Rohstoffe mbH

Der Grüne Punkt – Duales System Deutschland GmbH

**Product Specification 04/2009**
**Fraction-No. 310**

| **Sorting fraction:** | **P L A S T I C  F I L M S** |
|---|---|

**A Specification/Description**

Used, completely emptied, system-compatible articles made of plastic film, surface > DIN A4, e.g. bags, carrier bags and shrink-wrapping film, incl. packaging parts such as labels etc.

The supplementary sheet is part of this specification!

**B Purity**

At least 92 mass % in accordance with the Specification/Description.

**C Impurities**

| | |
|---|---|
| Max. total amount of impurities | 8 mass % |
| Metallic and mineral impurities with an item weight of > 100 g are not permitted! | |
| Other metal articles | < 0.5 mass % |
| Other plastic articles | < 4 mass % |
| Other residual materials | < 4 mass % |

Examples of impurities:

- Glass
- Paper, cardboard
- Composite paper/cardboard materials (e.g. beverage cartons)
- Aluminised plastics
- Other materials (e.g. rubber, stones, wood, textiles, nappies)
- Compostable waste (e.g. food, garden waste)

**D Delivery form**

- Transportable bales
- Dimension and density of the bales must be chosen so as to ensure that a tarpaulin truck (loading area 12.60 m x 2.40 m; lateral loading height min. 2.60 m) can be loaded with a minimum loading of 23 t
- Dry-stored
- Produced with conventional bale presses
- Identified with DSD bale label stating the sorting plant No., fraction No. and production date

Deutsche Gesellschaft für Kreislaufwirtschaft und Rohstoffe mbH

Der Grüne Punkt –
Duales System Deutschland GmbH

# Produktspezifikation 05/2012
# Fraktions-Nr. 324

**Sortierfraktion:** **POLYPROPYLEN**

## A Spezifikation/Beschreibung

Gebrauchte, restentleerte, formstabile, systemverträgliche Kunststoffartikel aus Polypropylen, Volumen ≤ 5 Liter wie z. B. Flaschen, Schalen und Becher, inkl. Nebenbestandteilen wie Verschlüssen, Etiketten usw.

Das Beiblatt ist Bestandteil dieser Spezifikation!

## B Reinheit

mindestens 94 Masse-% gemäß Spezifikation/Beschreibung

## C Störstoffe

| | |
|---|---|
| Maximaler Gesamtstörstoffanteil | 6 Masse-% |

Metallische und mineralische Störstoffe mit einem Stückgewicht > 100 g und Kartuschen für Dichtmassen dürfen nicht enthalten sein!

| | |
|---|---|
| Sonstige Metall-Artikel | < 0,5 Masse-% |
| Formstabile PE-Artikel | < 1 Masse-% |
| Geschäumte Kunststoffe inkl. EPS-Artikel | < 0,5 Masse-% |
| Kunststoff-Folien | < 2 Masse-% |
| Sonstige Reststoffe | < 3 Masse-% |

Reststoffbeispiele:
- Glas
- Papier, Pappe, Karton
- PPK-Verbundmaterialien (z. B. Flüssigkeitskartons)
- Aluminium-bedampfte Kunststoffe
- Fremdmaterialien (z. B. Gummi, Steine, Holz, Textilien, Windeln)
- kompostierbare Abfälle (z. B. Lebensmittel, Gartenabfälle)

## D Lieferform

- transportfähige Ballen
- Abmessungen und Dichte der Ballen sind so zu bemessen, dass ein Planen-LKW (Ladefläche 12,60 m x 2,40 m; seitl. Durchladehöhe min. 2,60 m) mit einer Mindestauslastung von 17 t beladen werden kann
- trocken gelagert
- Herstellung durch handelsübliche Ballenpressen
- Kennzeichnung durch Ballenanhänger versehen mit Sortieranlagen-Nr., Fraktionsnummer und Produktionsdatum

DKR
Deutsche Gesellschaft für Kreislaufwirtschaft und Rohstoffe mbH

Der Grüne Punkt –
Duales System Deutschland GmbH

# Produktspezifikation 05/2012
# Fraktions-Nr. 329

| **Sortierfraktion:** | **P O L Y E T H Y L E N** |
|---|---|

## A Spezifikation/Beschreibung

Gebrauchte, restentleerte, formstabile, systemverträgliche Kunststoffartikel aus Polyethylen, Volumen ≤ 5 Liter wie z. B. Flaschen und Schalen, inkl. Nebenbestandteilen wie Verschlüsse, Etiketten usw.

Das Beiblatt ist Bestandteil dieser Spezifikation!

## B Reinheit

mindestens 94 Masse-% gemäß Spezifikation/Beschreibung

## C Störstoffe

| | |
|---|---|
| Maximaler Gesamtstörstoffanteil | 6 Masse-% |

Metallische und mineralische Störstoffe mit einem Stückgewicht > 100 g und Kartuschen für Dichtmassen dürfen nicht enthalten sein!

| | |
|---|---|
| Sonstige Metall-Artikel | < 0,5 Masse-% |
| Formstabile PP-Artikel | < 3 Masse-% |
| Geschäumte Kunststoffe inkl. EPS-Artikel | < 0,5 Masse-% |
| Kunststoff-Folien | < 5 Masse-% |
| Sonstige Reststoffe | < 3 Masse-% |

Reststoffbeispiele:
- Glas
- Papier, Pappe, Karton
- PPK-Verbundmaterialien (z. B. Flüssigkeitskartons)
- Aluminium-bedampfte Kunststoffe
- Fremdmaterialien (z. B. Gummi, Steine, Holz, Textilien, Windeln)
- kompostierbare Abfälle (z. B. Lebensmittel, Gartenabfälle)

## D Lieferform

- transportfähige Ballen
- Abmessungen und Dichte der Ballen sind so zu bemessen, dass ein Planen-LKW (Ladefläche 12,60 m x 2,40 m; seitl. Durchladehöhe min. 2,60 m) mit einer Mindestauslastung von 17 t beladen werden kann
- trocken gelagert
- Herstellung durch handelsübliche Ballenpressen
- Kennzeichnung durch Ballenanhänger versehen mit Sortieranlagen-Nr., Fraktionsnummer und Produktionsdatum

Deutsche Gesellschaft für Kreislaufwirtschaft und Rohstoffe mbH

Der Grüne Punkt – Duales System Deutschland GmbH

# Product Specification 04/2009
# Fraction-No. 340

**Sorting fraction:** **E X P A N D E D  P O L Y S T Y R E N E**

## A Specification/Description

Used, completely emptied, system-compatible packaging made of coarse-grained, white expanded polystyrene, incl. packaging parts such as labels etc.

The supplementary sheet is part of this specification!

## B Purity

At least 97 mass % in accordance with the Specification/Description.

## C Impurities

Max. total amount of impurities 3 mass %

Metallic and mineral impurities with an item weight of > 100 g and packaging chips are not permitted!

Other metal articles < 0.5 mass %

Examples of impurities:

- Glass
- Paper, cardboard
- Composite paper/cardboard materials (e.g. beverage cartons)
- Aluminised plastics
- Other materials (e.g. rubber, stones, wood, textiles, nappies)
- Compostable waste (e.g. food, garden waste)

## D Delivery form

- in 1 m³ or 2.5 m³ big bags or
- Transportable bales

  Dimension and density of the bales must be chosen so as to ensure that a tarpaulin truck (loading area 12.60 m x 2.40 m; lateral loading height min. 2.60 m) can be loaded with a minimum loading of 0,7 t
- Dry-stored
- Produced with conventional bale presses
- Identified with DSD bale label stating the sorting plant No., fraction No. and production date

Deutsche Gesellschaft für Kreislaufwirtschaft und Rohstoffe mbH

Der Grüne Punkt – Duales System Deutschland GmbH

# Product Specification 04/2009
# Fraction-No. 350

**Sorting fraction:** **M I X E D  P L A S T I C S**

## A Specification/Description

Used, completely emptied, system-compatible articles made of plastics that are typical for packaging (PE, PP, PS, PET) incl. packaging parts such as caps, lids, labels etc.

The supplementary sheet is part of this specification!

## B Purity

At least 90 mass % in accordance with the Specification/Description.

## C Impurities

| | |
|---|---|
| Max. total amount of impurities | 10 mass % |
| Metallic and mineral impurities with an item weight of > 100 g are not permitted! | |
| Paper, cardboard | < 5 mass % |
| Other metal articles | < 2 mass % |
| PET bottles, transparent | < 4 mass % |
| PVC articles other than packaging | < 0.5 mass % |
| Other residual materials | < 3 mass % |

Examples of impurities:

- Glass
- Composite paper/cardboard materials (e.g. beverage cartons)
- Other materials (e.g. rubber, stones, wood, textiles, nappies)
- Compostable waste (e.g. food, garden waste)

## D Delivery form

- Transportable bales
- Dimension and density of the bales must be chosen so as to ensure that a tarpaulin truck (loading area 12.60 m x 2.40 m; lateral loading height min. 2.60 m) can be loaded with a minimum loading of 21 t
- Dry-stored
- Produced with conventional bale presses
- Identified with DSD bale label stating the sorting plant No., fraction No. and production date

Kennisinstituut Duurzaam Verpakken

## Product specification 05/2016

| **Sorting fraction:** | **Mixed Polyolefin (MPO)** |
|---|---|

**A Specification/Description**

Used, residue-drained, system-compatible articles made of Polyethylene (PE) and Polypropylene (PP), volume ≤ 5 liter, e.g. bottles, dishes and tubs, including packaging parts like caps, labels etc.

System-compatible implies that the plastic article is not shredded and is collected by systems of source separation or post-consumer separation as applied in Dutch municipalities.

**B Purity**

At least 90 mass % in accordance with the Specification/Description

**C Impurities**

Max. total amount of impurities 10 mass %

Metallic and mineral impurities with an item weight of > 100 g and cartridges for sealants are not permitted

| | |
|---|---|
| Other metal articles | < 0.5 mass % |
| Foamed plastics incl. EPS articles | < 0.5 mass % |
| PVC articles | < 0,2 mass % |
| Other non PE/PP articles (PET and PS) | < 7,5 mass % |
| Other residual materials | < 4 mass % |

Examples of impurities:

- Glass
- Paper, cardboard, paper board containers
- Composite paper/cardboard materials (e.g. beverage cartons)
- Aluminised plastics
- Other materials (e.g. rubber, stones, wood, textiles, nappies)
- Compostable waste (e.g. food, garden waste)

The maximum total impurity content is the share of all impurities contained in the fraction and must on no account be exceeded.

**D Form of delivery**

- Transportable bales
- Dimensions and density of the bales must be chosen so as to ensure that a tarpaulin truck (loading area 12.60 m x 2.40 m; lateral loading height min. 2.60 m) can be loaded with a minimum loading of 14 t
- stored in a dry place
- produced using commercially available bale presses
- identified by bale tags provided with Sorting Line Number, Fraction Number and production date

Deutsche Gesellschaft für Kreislaufwirtschaft und Rohstoffe mbH

Der Grüne Punkt – Duales System Deutschland GmbH

# Produktspezifikation 08/2014
# Fraktions-Nr. 328-1

| **Sortierfraktion:** | **Misch – P E T 9 0 / 1 0** |
|---|---|

**A Spezifikation/Beschreibung**

Gebrauchte, restentleerte, formstabile, systemverträgliche Verpackungen aus Polyethylenterephthalat (PET), Volumen ≤ 5 Liter in der Zusammensetzung

1. Flaschen transparent, z. B. Spülmittelflaschen, Getränkeflaschen

2. sonstige formstabile PET-Verpackungen, z. B. Becher, Schalen

Klar, bunt, opak inkl. Nebenbestandteilen wie Verschlüsse, Etiketten usw.

Das Beiblatt ist Bestandteil dieser Spezifikation!

**B Reinheit**

Mindestens 90 % PET – Flaschen, transparent
Maximal 10 % sonstige, formstabile Verpackungen aus PET
Masse-% gemäß Spezifikation/Beschreibung

**C Störstoffe**

| | |
|---|---|
| Maximaler Gesamtstörstoffanteil | 2 Masse-% |

Metallische und mineralische Störstoffe mit einem Stückgewicht > 100 g dürfen nicht enthalten sein!

| | |
|---|---|
| Sonstige Metall-Artikel | < 0,5 Masse-% |
| sonstige Kunststoff-Artikel | < 2 Masse-% |
| PVC-Artikel | < 0,1 Masse-% |
| Sonstige Reststoffe | < 2 Masse-% |

Reststoffbeispiele:
- Glas
- Papier, Pappe, Karton
- PPK-Verbundmaterialien (z. B. Flüssigkeitskartons)
- Aluminium-bedampfte Kunststoffe
- Fremdmaterialien (z. B. Gummi, Steine, Holz, Textilien, Windeln)
- kompostierbare Abfälle (z. B. Lebensmittel, Gartenabfälle)

**D Lieferform**

- transportfähige Ballen
- Abmessungen und Dichte der Ballen sind so zu bemessen, dass ein Planen-LKW (Ladefläche 12,60 m x 2,40 m; seitl. Durchladehöhe min. 2,60 m) mit einer Mindestauslastung von 17 t beladen werden kann
- trocken gelagert
- Herstellung durch handelsübliche Ballenpressen
- Kennzeichnung durch Ballenanhänger versehen mit Sortieranlagen-Nr., Fraktionsnummer und Produktionsdatum

Deutsche Gesellschaft für Kreislaufwirtschaft und Rohstoffe mbH

Der Grüne Punkt – Duales System Deutschland GmbH

# Produktspezifikation 08/2014
# Fraktions-Nr. 328-1

| **Sortierfraktion:** | **Misch – P E T 9 0 / 1 0** |
|---|---|

**A Spezifikation/Beschreibung**

Gebrauchte, restentleerte, formstabile, systemverträgliche Verpackungen aus Polyethylenterephthalat (PET), Volumen ≤ 5 Liter in der Zusammensetzung

1. Flaschen transparent, z. B. Spülmittelflaschen, Getränkeflaschen

2. sonstige formstabile PET-Verpackungen, z. B. Becher, Schalen

Klar, bunt, opak inkl. Nebenbestandteilen wie Verschlüsse, Etiketten usw.

Das Beiblatt ist Bestandteil dieser Spezifikation!

**B Reinheit**

Mindestens 90 % PET – Flaschen, transparent
Maximal 10 % sonstige, formstabile Verpackungen aus PET
Masse-% gemäß Spezifikation/Beschreibung

**C Störstoffe**

| | |
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## Appendix C – Questionaire

1. Positionering

Niche actoren, experts, gemeente

1. Wat is je functie?
2. Kan je de marktpositie van het bedrijf kort omschrijven? (multinational, start-up, spin-off, joint-venture,…)
3. Hoe zou je circulaire economie omschrijven?
4. Vind je het een belangrijke ontwikkeling?
5. Wat is de huidige stand van zaken qua circulariteit en duurzaamheid?
6. Heeft het bedrijf al een circulair business model of denken jullie daarover na?
7. Hoe hebben jullie dat business model ontwikkeld of hoe zouden jullie zo'n model kunnen zien?

2. Multi level perspectief

Niche actoren, experts, gemeente

a. Landschap

- Exogene en autonome trends en grote crisissen
- Lange termijn ontwikkelingen: demografisch, milieu, macro-economisch, politiek, wereldbeeld.

8. Welke ontwikkelingen op internationaal en nationaal niveau zijn of kunnen van invloed zijn voor jullie bedrijf?

b. Regime

9. Welke ontwikkelingen op nationaal en regionaal niveau in de afval- en kunststofsector zijn of kunnen van invloed zijn voor jullie bedrijf?

c. Niche

niche actoren

10. Welke ontwikkelingen binnen de niche en groei van de niche (waarin jullie opereren) zijn of kunnen van invloed zijn voor jullie bedrijf?

Visies en verwachtingen

11. Wat is jullie visie als bedrijf? En is er ruimte in deze visie voor circulariteit? (een bedrijf moet een visie hebben al voordat ze de markt op gaan, anders ben je stuur- en richtingloos)

Actoren

12. Welke actoren zijn betrokken? (financiële actoren, leveranciers, gebruikers, producenten, NGO's, publieke autoriteiten, actoren uit de onderzoekswereld, verzekeraars, anderen)
13. Ontbreken er nog belangrijke actoren?

Leren

14. Wat zijn de leerdoelen?
15. Wat hebben jullie geleerd van het mogelijke project in Almere dat voor jullie relevant is? (technische aspecten, culturele aspecten, beleid, marktkansen, financiële arrangementen).
16. Is er sprake van een leerproces met/tussen verschillende stakeholders?

3. Businessmodel

Niche actoren

a. Waarde propositie

17. Welke types product maken jullie en in welke behoefte voorzien jullie daarmee?
18. Wie is jullie target groep? (product, klantsegment en relaties, waarde voor klant, samenleving en maatschappij)

b. Waarde creatie

19. Hoe creëren jullie waarde? (activiteiten, grondstoffen en middelen, distributiekanalen, partners en leveranciers, technologie en producteigenschappen)

c. Waardebepaling

20. Hoe ziet jullie verdienmodel eruit? (kostenstructuur en omzetstromen, waardebepaling voor belangrijke actoren, groeistrategie)

4. Ontwikkelingen

Experts

21. Wat zijn belangrijke ontwikkelingen op het gebied van kunststof recycling?
22. Wat zijn barrières in het recyclen van (mixed)kunststoffen?

5. Gemeente

Gemeente

23. Zijn of voelen jullie je eigenaar van het (kunststof) afval probleem?
24. Wat is jullie doel m.b.t. het kunststof huishoudelijk afval?
25. Welke rol willen jullie spelen in het bevorderen van de kunststof afval keten?