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Final Report

Dialogues on the appropriate management of substances of concern in the circular economy

by:
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Abstract: Dialogues on the appropriate management of substances of concern in the circular economy

The project "Dialogues on the appropriate management of substances of concern in the circular economy " aimed to create a common and well-founded understanding of the challenges that arise at the interfaces of chemicals and waste legislation between experts from industries and businesses and the national authorities from both regulatory areas. To this end, three workshops were held with participants from business and the specialised authorities, each of which focused on a selected aspect of the interface.

Based on the expert discussions, the authors identified and described approaches for action that contribute to strengthening the circular economy and ensuring effective risk management in the circulation of materials containing hazardous chemicals.

Kurzbeschreibung: Dialogues on the appropriate management of substances of concern in the circular economy

Das Vorhaben „Dialoge an der Schnittstelle zwischen Chemikalien- und Abfallrecht“ diente dazu, zwischen Fachexpert*innen aus der Unternehmenspraxis und der Verwaltung aus beiden Regelungsbereichen ein gemeinsames und fundiertes Verständnis über die Herausforderungen zu gewinnen, welche sich an den Schnittstellen des Chemikalien- und des Abfallrechts ergeben. Dazu wurden drei Workshops mit Teilnehmenden aus der Wirtschaft und den Fachbehörden durchgeführt, die jeweils einen ausgewählten Teilaspekt der Schnittstelle in den Fokus genommen haben.

Aufbauend auf den Fachdiskussionen wurden von den Autor*innen Handlungsansätze identifiziert und beschrieben, die zu einer Stärkung der Kreislaufführung und der Gewährleistung eines wirksamen Risikomanagements bei der Kreislaufführung von Materialströmen mit gefährlichen Inhaltsstoffen beitragen.

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List of abbreviations

AltautoV	German End-of-life Vehicles Ordinance
APV	LAGA Committee on Extended Product Stewardship
ASF	Additive Sustainable Footprint (sustainability footprint for additives)
AVV	German Waste Catalogue Ordinance
AwSV	Ordinance on Installations for Handling Substances Hazardous to Water
BattG	Battery law
BAuA	Federal Institute for Occupational Safety and Health
BfR	Federal Institute for Risk Assessment
BGBl	Federal Law Gazette
BImSchG	Federal Immission Control Act
BImSchV	Federal Immission Control Ordinance
BMUV	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
CLP	EU Regulation on the Classification, Labelling and Packaging of Substances and Mixtures
CMR	Carcinogenic, mutagenic, reprotoxic substances
DDT	1,1,1-Trichloro-2,2-bis(4-chlorophenyl)ethane
DGUV	German statutory accident insurance
DNEL	Derived No Effect Level (=concentration at which no effects are expected)
DPP	Digital Product Passport
EAG	German Waste Electrical Equipment Act
ECHA	European Chemicals Agency
EEE	Electrical and electronic equipment
EPS	Expanded polystyrene
EU	European Union
EWC	European waste catalogue
FE metals	Ferrous metals
GefStoffV	German Ordinance on Hazardous Substances
GHS	Globally Harmonised System of Classification, Labelling and Packaging of Substances and Mixtures
GPRSD	General Product Safety Directive (in Germany: Food & Consumer Goods Law)
GUT	Community of Environmentally Friendly Carpeting e.V.
HBCD	Hexabromocyclododecane
HP	Hazardous property
I4R	Information for recyclers
IDIS	International dismantling information system
IMDS	International Material Data System

JRC	Joint European Research Centre
KrWG	Circular Economy Act
LoW	List of Waste
NachwV	German Verification ordinance
OPE	Octylphenol ethyoxylate
OSH	Occupational Safety and Health
PBDE	Polybrominated diphenyl ethers
PBT	Persistent, bioaccumulative, toxic
PC	Physicochemical
PCB	Polychlorinated biphenyls
PCDD	Polychlorinated dibenzo-p-dioxins
PCDF	Polychlorinated dibenzofurans
PEC	Predicted environmental concentration
PIC	Regulation on the import and export of dangerous chemicals (prior informed consent regulation)
PNEC	Predicted No Effect Concentration (=estimated concentration below which no environmental effects are expected)
POP	Persistent organic pollutant (POP)
POP Waste Ordinance	German POP Waste Monitoring Ordinance
PVC	Polyvinyl chloride
REACH	Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemicals
RMM	Risk Management Measure
RoHS	Directive on the restriction of hazardous substances in electrical and electronic equipment
SCIP database	Substances of concern in products database
SDS	Safety Data Sheet
SoC	Substance of concern
SPI	Sustainable Product Initiative
SSbD	Safe and Sustainable by Design
SVHC	Substance of Very High Concern
TRGS	Technical Rules Hazardous Substances
UBA	German Environment Agency
UVCB	Substances with unknown and variable composition, complex reaction products and biological materials
UVPG	German environmental impact assessment act
VerpackG	German Packaging Act
VO	Ordinance
vPvB	Very persistent, very bioaccumulative

Waste Oil Ordinance	German Waste Oil Ordinance
Waste woodV	German Waste Wood Ordinance
WEEE	Waste electrical and electronic equipment
Wt. %	Weight percent
WFD	Waste Framework Directive
WHG	Federal Water Act

Summary

Objective and project background

The requirements adopted in recent decades in chemicals, product and waste legislation are implemented both through the individual responsibility of market actors and through statutory and sub-statutory regulations. As new findings are continuously being gained about the hazardous properties of substances as well as the possible environmental and health risks of their use, these legislations are subject to a dynamic adaption process.

According to the assessment of many market actors, the diversity of legal systems, the complexity of adaptation processes and inconsistent requirements and criteria regarding the hazardousness of substances, mixtures or articles as well as waste lead to friction losses at the interfaces of waste and chemicals legislation. This may hinder desirable market developments[1], targeted levels of protection could not be fully achieved or legal uncertainties could arise for the actors involved.

The project “Dialogues at the interface between chemicals and waste legislation” served to gain a common and well-founded understanding of the challenges that arise at the interfaces of chemicals and waste legislation between experts from business practice and the administration from both regulatory areas. In addition, approaches to solving these challenges were to be developed and discussed with the stakeholders involved. To address this, three workshops were held with participants from business and specialised authorities, each of which focused on a selected aspect of the interface.

For each of these specialist dialogues, the status quo of the topic was prepared in an internal working document. The programs were designed and questions prepared based on this expert knowledge. Due to the pandemic, the dialogues were organized per online videoconference each with 15 to 30 participants. The released presentations and documentation of the dialogue can be downloaded here.

Below the following will be briefly described:

1. Overarching issues and principles on the interface between chemicals and waste legislation,
2. the mutual interlocking between the two areas of legislation (=> Expert Dialogue 1),
3. the problem of information flows on substances of concern between the chemicals and waste sectors (=> Expert Dialogue 2) as well as
4. approaches to strengthen the waste hierarchy for wastes with hazardous chemicals (=> Expert Dialogue 3).

Based on this, there is a sketchy presentation of approaches to action which, in the view of the authors, could strengthen the recycling of materials with hazardous ingredients in the interaction of chemicals and waste legislation.

All these aspects can be found in a more comprehensively detailed form in the overall report.

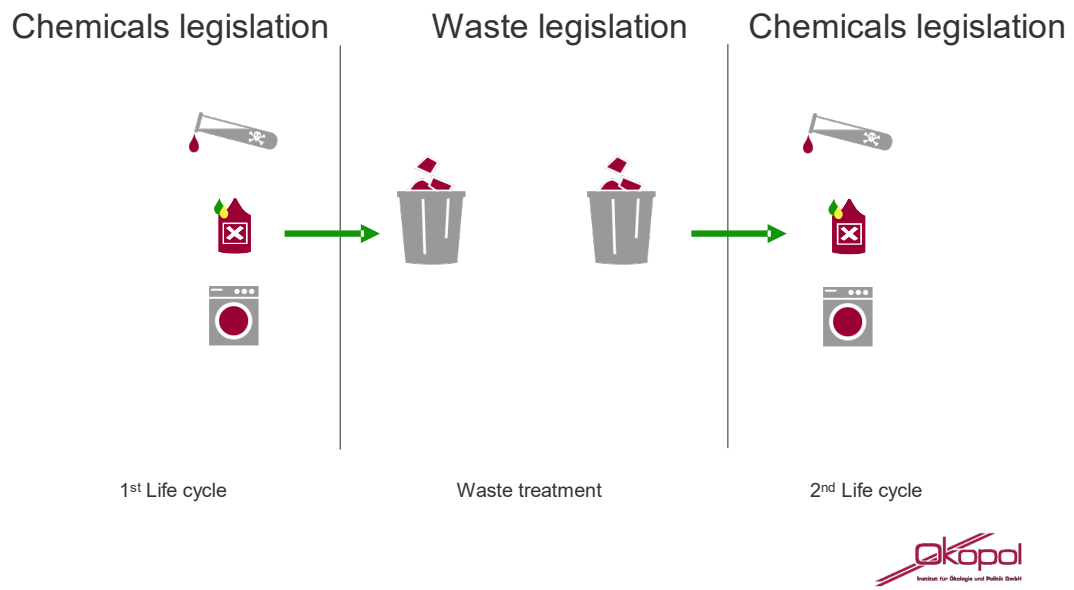
Technical basics for understanding the interfaces between chemicals and waste legislation

Chemical and waste legislation are clearly separated and mutually exclusive, i.e. an "object" can only fall under one of the two regulatory areas. The definition of waste (§ 3 (1) of the German Circular Economy Act (Kreislaufwirtschaftsgesetz (KrWG))) is decisive for which legislation is applicable: "[...] *substance or object which its owner discards, intends to discard or must discard"*. If a waste product is properly and harmlessly recycled and the waste status ends, the

[1] E.g. to establish circular economy concepts in the framework of the circular economy.

requirements of the chemical legislation automatically and potentially other product legislation apply again (Figure 1). In a circular economy, substances and objects can switch between chemical legislation and waste legislation several times.

Figure 1: Crossings between chemicals and waste legislation



Source: own representation, Ökopol

Subjects of regulation in chemicals and waste legislation

The subjects of regulation in chemicals and waste legislation differ fundamentally. Chemical legislation distinguishes between three clearly defined "objects": substance, mixture and article, for which there are different legal consequences according to these definitions. In contrast, the defined object of regulation in waste legislation is waste. The concept of waste is not further differentiated. However, to the same extent it covers the "objects" of substances, mixtures and articles, which are more differentiated under chemicals legislation. A further differentiation is made in waste legislation by the types of waste and the waste origin in the form of the waste codes.

Substances, Mixtures and Articles

The legal requirements for substances, mixtures and articles are laid down in the Regulation on Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) and the Regulation on Classification, Labelling and Packaging of Substances and Mixtures (CLP).

- Substances must be registered from a production/import quantity of 1 ton per year and manufacturer, respectively importer. Under chemical legislation recycling is a manufacture, which is why recyclers are also subject to registration. Exemptions are possible under certain conditions.
  Information on the properties and uses of substances must be provided for the registration. The data on substance properties are used to identify, according to the CLP methodology, if and which hazard classes and categories are to be assigned to a substance CLP (=> "chemical classification").
- Mixtures do not have to be registered. However, they must be checked with regard to their hazardous properties and classified in accordance to CLP.

- For classified substances and mixtures, safety data sheets (SDSs) with corresponding information and instructions for safe use must be prepared and passed on to customers.
- For articles, there are no requirements defined by chemicals legislation with the exception to communicate the presence of any substances of very high concern (SVHC) - in concentrations of > 0.1%.

Waste

According to the KrWG, the producers and owners of waste are obliged to recycle waste in such a way that no damage to the environment or health occurs and - if recycling is not possible - to dispose of it without causing damage. Waste is classified according to the procedure of the Waste Classification Ordinance (AVV) (=> "waste classification"). When waste with a mirror entry is examined for its hazard-relevant properties in this procedure, the classification and labeling of substances and mixtures from the chemicals legislation is used. Since methods and criteria for the classification of chemicals and waste legislation differ with regard to individual aspects, the two systems can only be compared to a limited extent.

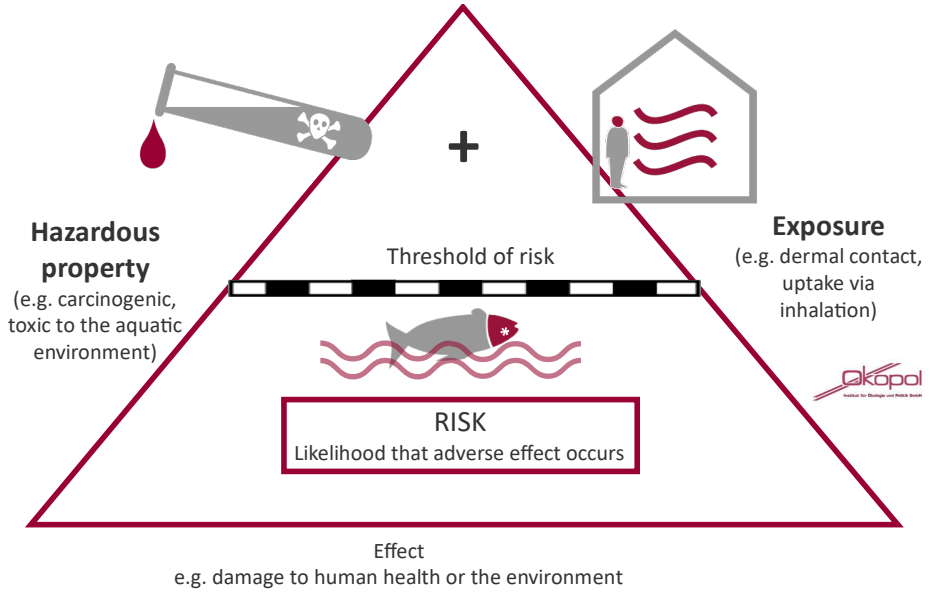
Hazardous substances in material cycles and products

Many chemicals are intentionally added in the manufacturing process of materials or products to produce specific functionalities. In addition, they can also enter the material and product streams as impurities from raw materials, processing aids or through (undesirable) chemical reactions. While manufacturers know the identity and properties of intentionally used substances, in practice they are often not exactly aware of the identity and quantity proportions of impurities.

Ingredients classified as hazardous can be separated and/or destroyed from product waste streams during waste treatment or carried over into secondary materials and subsequently start a new life phase. Thus, the use of secondary materials is also a possible entry pathway for hazardous substances into the products on the market.

In order to check whether hazardous substances in materials as well as in products can harm the environment or health, the instrument of risk assessment is used in chemicals legislation. This compares the concentration/dose above which adverse effects on humans and/or the environment are expected with the concentration/dose to which humans and the environment are exposed through the use of the substance (exposure).

Figure 2: Terms of the substance – related risk identification



Source: own representation, Ökopol

If a risk assessment shows that a particular use is "not safe" (risks to humans and/or the environment), this use cannot be registered and is therefore not permitted. According to the Foods and Consumer Goods Law, product producers and importers are required to check and ensure that no risks arise for the users of these products when they are used as intended.

In principle, actors in the waste treatment chain are also required to decide which treatment processes are appropriate for a waste stream based on a consideration of potential harm to humans and the environment.

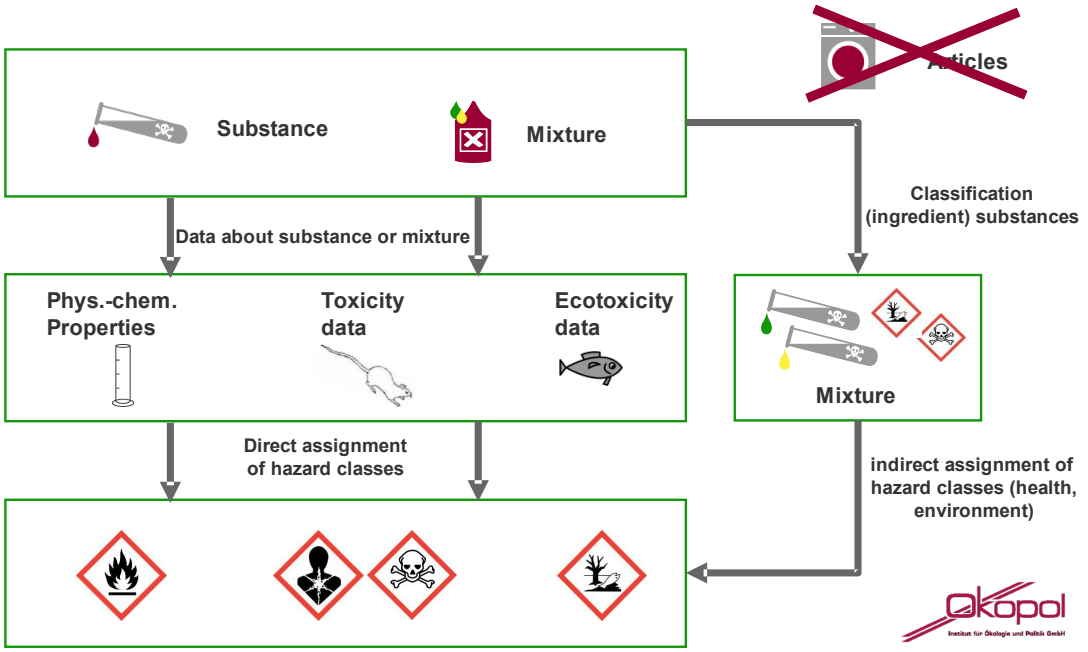
Interlocking between chemicals and waste legislation (=> Expert Dialogue 1)

Only representatives from public authorities took part in this expert dialogue. Within the framework of the dialogue topic, the aim was to discuss legal ambiguities and, in some cases, differences at the interface between chemicals and waste legislation. This included, in particular, the discussion of the procedures for classification as "hazardous" in chemicals legislation and in waste legislation and the legal consequences triggered by this.

Procedure for classification under chemical legislation

To determine which hazard classes and categories a substance fulfills, data from tests and other procedures are compared with the criteria of the CLP Regulation. Mixtures are classified based on the classifications and concentrations of their ingredients and/or based on tests on the mixture. Articles are not classified. The classification has to be done by the placers on the market (=> "self-classification"). The authorities can also classify substances uniformly in an EU procedure (=> "harmonized classification").

Figure 3: System of classification and labelling according to the CLP regulation



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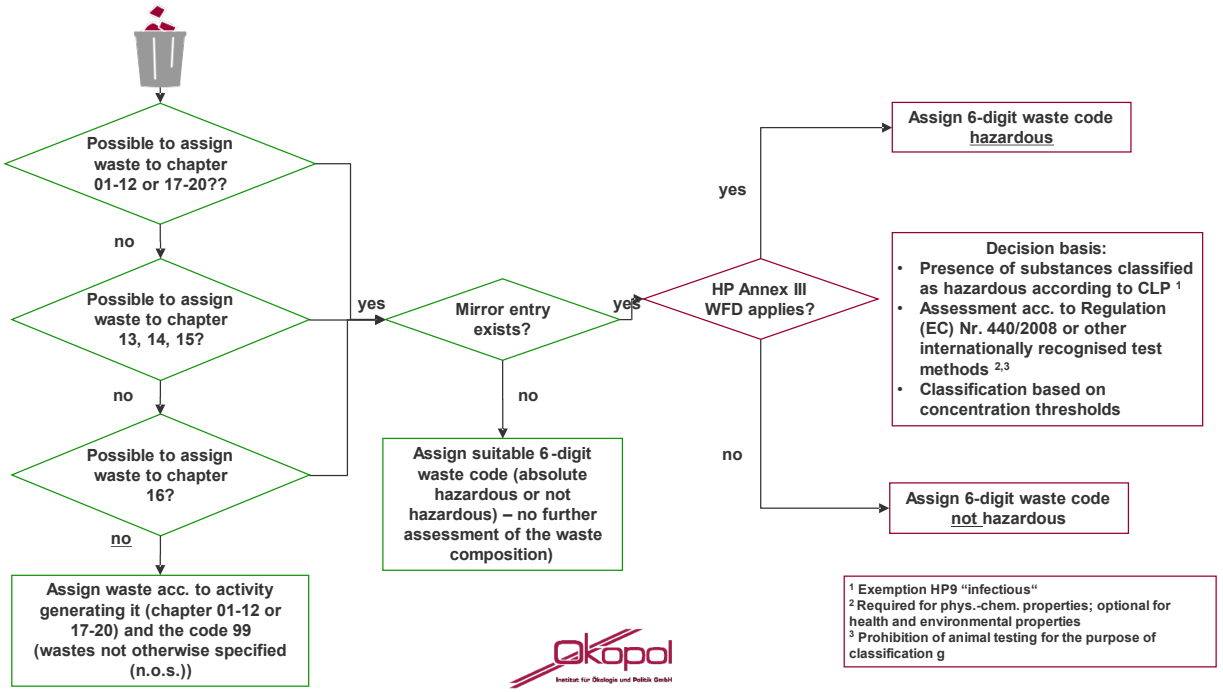
Procedure for waste legislation classification

Wastes are classified in accordance with the AVV by assigning a 6-digit waste code. The waste catalog is divided into 20 chapters on the origin of waste. These are subdivided into groups and further specified with regard to the types of waste. Waste codes with an "asterisk" indicate wastes that contain "hazardous chemicals". In many cases, they are so-called "mirror entries" to otherwise largely similar types of waste. However, there are also waste codes with asterisks in various areas of origin that already specifically name hazardous substances, e.g. mercury, polychlorinated biphenyls (PCBs), etc.

Waste producers are obliged to assign their waste to a waste code. For this purpose, they usually draw on the expertise of waste management companies and/or the enforcement authorities. In addition, guidelines exist for waste classification. If a waste is assigned to a waste code without a mirror entry on the basis of its origin, this assignment to the area of origin also already determines that the waste is "non-hazardous" or “hazardous”, respectively. If mirror entries exist, the so-called "HP criteria" must be used to check and decide whether the waste is hazardous, with reference to the constituents and their concentration in the waste. The following graphic shows this procedure in a schematic overview.

Figure 4: Decision tree for waste classification



Source: own representation, Ökopol

The selection of a waste code for mirror entries is made on the basis of the ingredients in line with the chemical classification of mixtures in accordance with Annex III of the EU Hazardous Waste Directive. This annex defines the criteria for hazardous properties (HP), which are similar to those in chemicals legislation. In addition, according to AVV, wastes containing certain persistent organic pollutants (POPs) above defined concentration thresholds are also to be classified as hazardous.

With wastes that are generated during the use of substances or mixtures, i.e. with many of the industrially generated production wastes, the substance properties relevant for the waste classification (hazardous or non-hazardous) can often be obtained from the available SDS.

For articles, on the other hand, the relevant information on the content of hazardous substances is usually missing. It is often assumed by market players that substances in articles cannot create risks because the products are, after all, "safe" on the market. However, this assumption is incorrect, since waste legislation classification is based only on the content of a "hazardous" ingredient.

Legal consequences of classifying substances and mixtures or wastes as "hazardous"

If substances or mixtures are classified as hazardous, various legal consequences could be triggered depending on the hazard class, including:

- Obligation to carry out an exposure assessment and risk assessment under REACH and to provide safety data sheets,
- Restriction of use in certain (chemical) products and/or mandatory approval for these uses,
- Obligation to take into account in workplace risk assessments and, if necessary, implement measures to protect employees from chemical-related risks,

- Obligation to take this into account in the permitting of plants and, if necessary, in emergency plans and storage (plant safety).

The classification of a waste as hazardous triggers additional legal requirements, including:

- Documentation requirements regarding waste treatment (waste legislation monitoring through the consignment note procedure),
- Restriction of permissible waste operations in terms of mixing and separation,
- Obligation to include in the permit of the facilities in the case of facilities that treat these wastes, and if necessary, supplementary requirements for the design of the facility.

End of waste and beginning of product status

Both the beginning and the end of the waste status are not clearly defined and are therefore "grey areas" that require clarification in practice. End-of-waste criteria have been developed at EU level for some material streams. However, for further material streams (e.g. plastics or building materials), harmonized criteria for the end of waste are missing, leaving the decision on whether an object loses its waste status to the self-assessment of the waste and recycling actors.

Main discussion points of the Expert Dialogue 1

In the discussion at Expert Dialogue 1, the following points were highlighted:

- Changes in the classification of substances have a direct impact on the classification of waste as "hazardous". The resulting legal consequences can impose significant economic and practical burdens on waste producers.
- Information on the content of hazardous substances in the waste phase is lacking, especially for long-lived products. If the legal chemical classifications of the ingredients change, this can also change the classification under waste legislation during this period.
- Substances/mixtures must not have any harmful effects on humans or the environment after they have ceased to be waste. Due to the insufficient information on the composition of "post-consumer" waste, recycling companies face considerable uncertainties regarding secondary products and materials.
- The possibilities for influencing the product design from the waste sector in order to prevent problems later when they are disposed of have so far been very limited.
- The EU waste catalogue, which is considered outdated, as well as the use of test methods for the verification of HP criteria, which was criticized at the workshop, should be reviewed and revised at EU level. Transitional (national) solutions should be developed for the period until the new regulations are in place.
- Since waste is mostly classified in practice on the basis of waste origin, the consequences of the dynamics of classifications of chemicals (which become waste constituents) are relativized in the waste sector. In many cases, there are no mirror entries at all in this area.
- The duality of waste classification (hazardous/non-hazardous) cannot satisfy the information needs of, e.g., recycling actors. A more differentiated approach to complex substance information was seen as a central prerequisite for a functioning circular economy.

Information flows on substances of concern between the chemicals and waste sectors (=> Expert Dialogue 2)

The aim of the 2nd Expert Dialogue was to discuss the legal situation and practical challenges for the flow of information on substances of concern in products with regard to enabling a circular economy. The aim was to develop solutions for improving the flow of information.

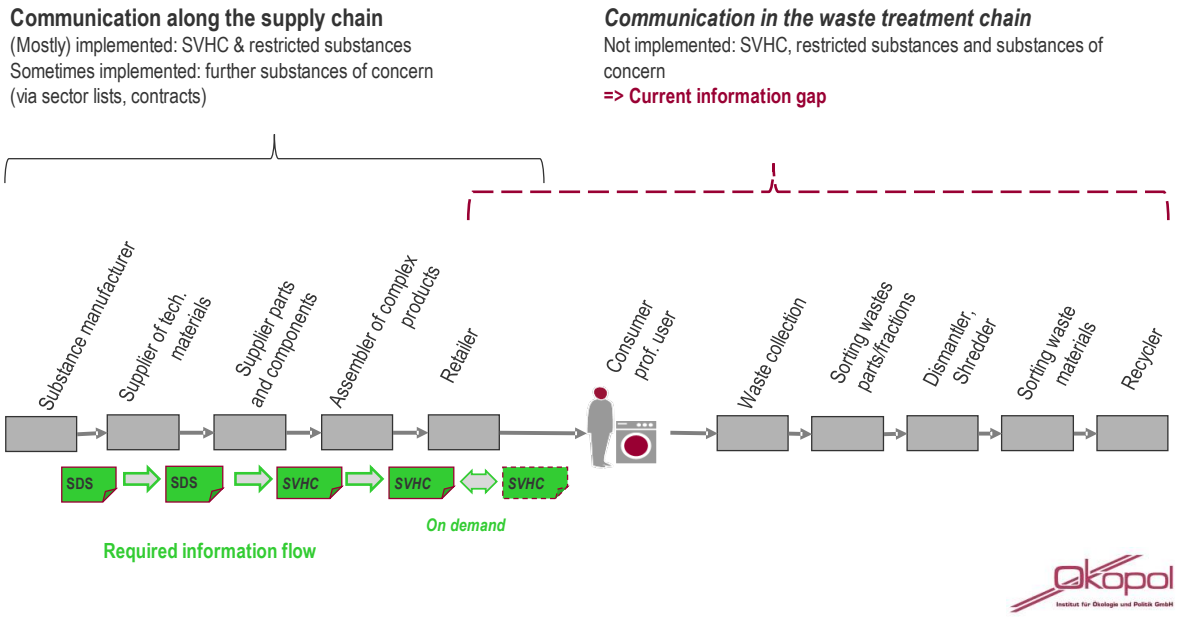
Market actors need information about hazardous substances in products in order to consider which risk management measures are appropriate along the entire life cycle. Within the primary supply chains, there are legal requirements for information disclosure, as well as regulations and instruments that go beyond this. Also within the waste phase, there is an established system of information disclosure for waste classified as "hazardous".

Nevertheless, the central challenge for the actors of waste management is the lack of concrete and reliable information about the content of hazardous substances in waste consisting of objects that were formerly articles, as well as the assessment of resulting risks for humans and the environment during their treatment. This makes risk management in waste treatment more difficult and "informed" sorting and treatment decisions can only be made at great expense in order to produce (safe) secondary materials in a targeted manner.

Information requirements under chemicals legislation

For substances and mixtures classified as hazardous, an SDS must be provided to the downstream user (customer). This must contain information on the hazardous properties of the chemicals as well as instructions for safe use and disposal, including applicable waste codes. The information flow through the SDS ends when a substance/mixture becomes an article. For articles, there is only an obligation to inform customers whether SVHCs are contained in the article in a concentration > 0.1% by weight (Art. 33 REACH). Communication about hazardous substances ends entirely with the use phase of the products. The resulting "information gap" on hazardous substances in articles and in waste streams is graphically illustrated in Figure 5.

Figure 5: Current situation of mandatory information requirements on substances of concern in articles



Source: own representation, Ökopol

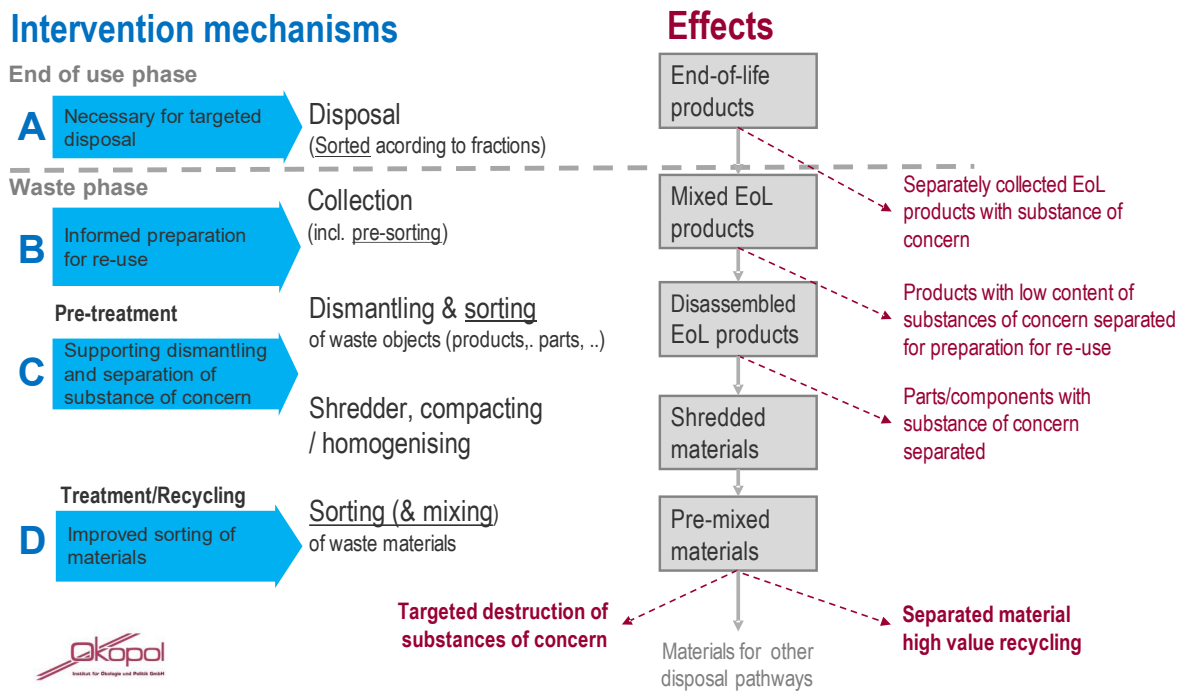
Information requirements in waste legislation

According to the German's Chemicals Law (ChemG) § 16f, suppliers of articles are obliged to report information on SVHCs contained in their products in concentrations above 0.1% by weight to a publicly accessible database of ECHA (SCIP). To date, there is a lack of ways for waste management actors to extract this information in a form and aggregation that is helpful to them. In addition, some information important for waste stakeholders is missing, such as the real SVHC concentration or also the content of other regulated non-SVHC substances. Therefore, the SCIP database can reduce the "information gap" but not close it. The communication obligations established in the context of product stewardship (e.g. End-of-Life Vehicles Ordinance) and voluntary instruments can also only slightly reduce the information gap (for waste from objects that were previously articles).

Need for information on substances in products/waste to improve circular economy.

In a study for the EU Commission[2], it was shown that additional information on substances of concern in articles can improve waste treatment and recycling, especially if it becomes available for sorting steps in waste management treatment chains. Four **intervention mechanisms** for improved and "informed sorting" were identified.

Figure 6: Intervention mechanisms for improved circulation through additional substance information



Source: own representation, Ökopol

[2] Oekopol (2020): "Information Flows on substances of concern in products from supply chains to waste operators, Final report", for the Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs. (InfoFlow study).

These four intervention mechanisms are briefly described below:

- **Mechanism A:** End-of-life products are (pre-) sorted and specifically disposed of before they become waste. Example: Construction companies sort out HBCD-free insulation boards for EPS recycling.
- **Mechanism B**: Products for which detailed information on the content of hazardous substances is available are marked and thus easily selected for preparation for reuse. Example: A label on cell phones indicates whether enough information is available for re-marketing. In the further process, the detailed data is used to ensure that the product is placed back on the market in compliance with the law.
- **Mechanism C:** Readily available information on the content of substances of concern in product (components) allows their rapid separation from the waste stream. Example: Textiles containing PFAS are separated from PFAS-free textiles. This way, pollutants are removed from the material streams that are sent for further recycling.
- **Mechanism D:** Additional material information can support both sorting and the targeted blending of material streams from different areas of origin, which is sometimes necessary for technical reasons, and thus leads to better defined input fractions into the actual material recycling processes, e.g. in plastics recycling.

According to the operators of waste treatment facilities, information on substances of concern in waste is particularly helpful when it is aggregated and relates to

- groups of substances instead of individual substances (e.g. to all brominated flame retardants),
- the assemblies/parts usually produced during dismantling and cutting processes,
- the real contents and quantity proportions in devices/assemblies or materials,

and they are easy to read and interpret under the conditions of the (sorting) processes.

Solution approaches for strengthening information flows

Approaches to transfer substance information from actors in the primary supply chain to those in the waste treatment chain must overcome two challenges:

- There is no clearly (pre)defined relationship between the sender of the information in the primary supply chain and the recipient in waste treatment.
- The service life can range from a few weeks/days to more than 50 years.

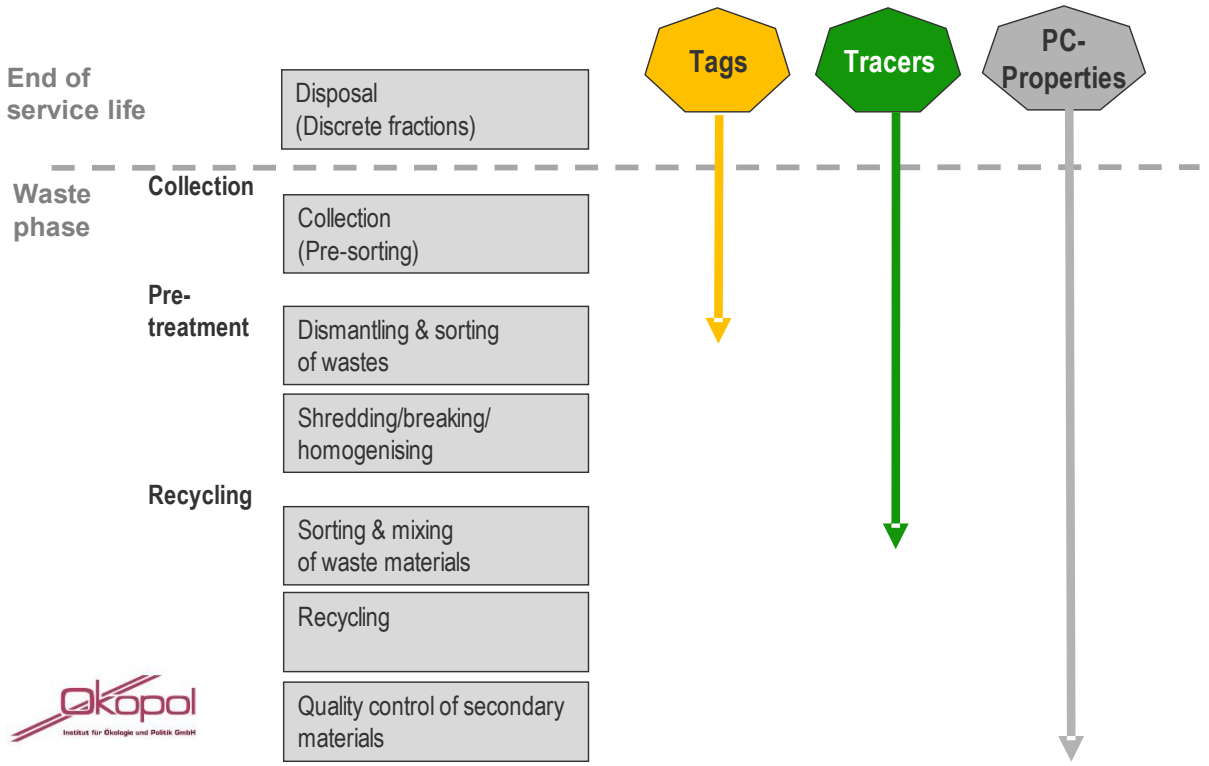
Basically, four approaches to information transfer can be distinguished. With a **flag**, the information to be transmitted is transported directly on/with the respective information carrier. A **Unique Identifier** "merely" conveys the unique identity of the item, e.g. in the form of a serial number. Based on the identity, detailed information about the product can be read out in a linked database. Another approach is the measurement of substances in materials based on their **physicochemical (PC) properties**. In addition, the substance inventory of a product can be stored in a **separate documentation** that is only indirectly linked to the product, e.g. in a building pass.

Physically, the carriers of the information can be so-called **tags**, which are applied to or in the surface of an article. The information can be directly "readable" (labels, symbols, etc.) or

"machine readable" and encrypted (e.g. QR codes, holograms, RFID). **Tracers** are substances that can be introduced into a material matrix and easily measured. They can (to date) only transmit "binary" information. Tracers "compete" with the direct measurement of substances in materials based on their properties.

The suitability of information carriers for information transfer into the waste treatment chain depends on the process they are intended to inform or how far they can penetrate into typical treatment processes (penetration depth) without destruction (and thus loss of information).

Figure 7: Penetration depth of information carriers into the waste treatment chains



Source: own representation, Ökopol

Tracers can withstand even harsh conditions during product use and waste handling. Therefore, they also reach the later steps in the waste treatment chain up to the actual material recycling. Tags are much more sensitive and can already be destroyed by "improper" use or by "physical" stress during waste treatment. They are suitable for informing the earlier steps in waste treatment.

Transporting complex (material) information to the end of the recycling chain (manufactured secondary materials) is currently not possible with any of these techniques. However, the PC properties of a secondary material can be analyzed and thus gain information on the content of substances of concern.

Discussions in Expert Dialogue 2

The following key points were discussed at the Expert Dialogue and recorded as the assessment of the participating experts.

- In order to achieve the goals of the Green Deal with regard to the (pollution-free) circular economy, the players in the waste sector need meaningful information on hazardous

substances in materials and products. The implementation of design-for-recycling approaches also needs to be further strengthened, according to all participants.

- The aforementioned systematics of intervention mechanisms and approaches for information transfer is very helpful to support the discussion on (improvements of) information flows.
- To improve information flows, a continuous dialogue on the concrete need for information between the actors within the waste treatment chains as well as between the waste sector and the primary supply chains is necessary.
- Labelling activities for appliances containing particularly problematic ingredients (such as flammable lithium-ion batteries or dusty vacuum insulation panels) are useful to enable separate treatment.
- The labelling of products with regard to hazardous chemicals content has a good chance of being implemented in practice if it can be read at normal belt speeds by large sorting plants with a reasonable amount of effort.
- There is no one-size-fits-all solution for information transfer and for each sorting technique and material stream different information transfer tools can be effective.
- Currently, there are no economically self-supporting solutions for the further optimisation of recycled material qualities. Separation and sorting costs are too high compared to the attainable prices for the secondary material qualities.
- Clearly defined "target qualities" for secondary materials would facilitate the alignment of waste management sorting processes and promote the sale of recycled materials.
- There was no consensus on whether the targeted blending of different recycling materials is useful to achieve such quality targets.
- It was discussed that primary and secondary materials should be considered "similar" if the risk potential for a defined use pattern is comparable. It cannot be a matter of reproducing the material composition of primary raw materials 1:1.
- In contrast, the concept of unspecified and thus (almost arbitrarily) broad use patterns for recyclates is not seen as sustainable.

Approaches to strengthening the waste hierarchy for wastes with hazardous contents (=> Expert Dialogue 3)

The aim of the third Expert Dialogue was to discuss the current legal situation and the practical challenges of implementing the waste hierarchy, to enable an exchange between representatives of public authorities and practitioners and to collectively develop solutions in the form of decision criteria for the implementation of the waste hierarchy.

The political guidelines for sustainable and circular economy are based on the following:

1. prevention/reduction of the use of substances of concern and of waste containing hazardous substances, as well as of the overall amount of waste;
2. waste treatment that directs the largest possible quantities of products to preparation for reuse that are safe (from a material point of view) and that comply with legal requirements;

3. recycling that converts as large a material stream as possible into secondary materials. This should either exclude the recycling of substances of concern or ensure that contaminated secondary materials are only used in well-controlled applications;
4. the removal of substances with (particularly) hazardous properties from material cycles.

In order to implement the goals of the EU Green Deal, actors in the waste sector need guidance on how to implement the legally defined waste hierarchy in waste treatment practice with regard to the levels of substances of concern in the waste streams. With this in mind, the third expert dialogue focused on the topic of "Strengthening the waste hierarchy: decision-making aids for the selection of treatment paths".

Existing legal requirements for the (selection of) waste treatment paths

According to the KrWG, the management of waste should a) protect the environment and health and b) increase the efficiency of resource use. How these two goals are measured and, if necessary, weighed against each other is not conclusively defined.

In waste legislation, the possible waste treatment measures form a hierarchy that must be taken into account when selecting the treatment path. In addition, the impacts of waste management on humans and the environment must be considered over the entire life cycle of the waste, i.e. including a second use phase if necessary. The order of priority of treatment options is:

- Prevention[3],
- Preparation for reuse,
- Recycling,
- Other utilisation, in particular energy recovery and backfilling,
- Disposal.

This order can be deviated from if protection goals can be better achieved in this way, e.g. a waste can be disposed of if it contains substances of concern that could create risks in the 2nd life cycle. In addition, technical and economic rationality may have an influence on the choice of treatment method. The BMUV has published guidelines on the interpretation of the ranking of recovery measures.

In the EU and at national level, "collection quotas" define the percentage of new products placed on the market that are to be collected and recorded separately once they have reached waste status. Recycling quotas define the percentage of waste generated or collected from these products that is to be sent for recycling. The implementation of the quotas is achieved in Germany by means of the extended producer responsibility. However, the quotas do not set qualitative requirements for the material composition of the waste or secondary materials produced, nor do they specify how the quotas are to be achieved.

Additional factors influencing the choice of waste treatment processes include the hazardousness of a waste (asterisked waste code), which may require, for example, that the treating facility meets appropriate permitting or technical requirements.

Chemicals legislation influences the choice of waste treatment processes through the requirements for placing the secondary materials on the market (e.g. registration obligation), as recycling is considered to be substance production. An exception to the registration obligation is

[3] Waste prevention was not relevant for the discussion, because the expert dialogue was focussed on aspects of waste treatment.

possible if a) the recovered substance is identical to an already registered substance and b) the company carrying out the recovery has appropriate safety information for the substance, e.g. in the form of a safety data sheet. In this respect, the recycling company must have sufficient knowledge about the recovered substances (identity) and corresponding information for a registration or an exemption thereof.

Furthermore, the recycling of waste containing SVHCs subject to authorisation may be restricted by the fact that an authorisation for the recycling company (and also its customers) must be available for the handling of the generated secondary materials. As authorisation applications are specific to the respective value chains, the activities of recycling companies and their customers are not covered by other authorisations. In addition, authorisation decisions to review potential risks at the end of (primary) substance use may require compliance with certain conditions in waste treatment, e.g. that no emissions to water arise from a process.

Wastes that contain persistent organic pollutants fall under the EU POPs regulation. For wastes, where the content of POPs reaches or exceeds defined thresholds, certain requirements are to be implemented for the waste treatment, including a prohibition to mix these wastes with other wastes and the requirement to irreversibly transform or destroy the POPs contained.

Also restrictions under REACH may influence the choice of treatment processes for wastes by prohibiting certain uses of substances or the presence of substances in products and thereby (may) have an impact on the possibilities of a placing back on the market after a preparation for reuse, or the placing on the market of secondary materials after a recycling process.

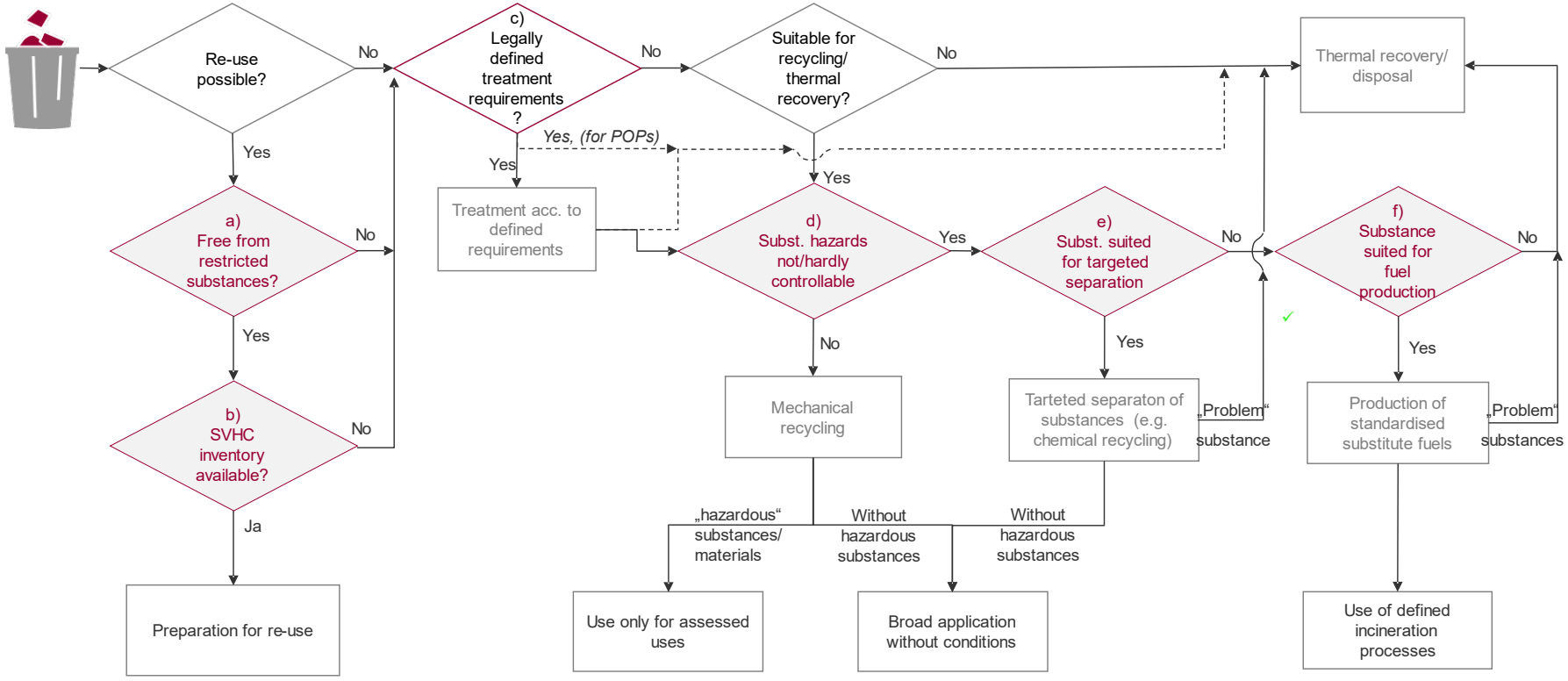
The choice of treatment options can also be limited by the fact that the subsequent placing on the market of recyclates has to comply with the requirements of chemical legislation and the necessary information is missing. After preparation for re-use, it is e.g. necessary to comply with the information obligation for SVHCs (according to Art. 33 of REACH) for the respective article or to be able to comply with it. Furthermore, chemical products (substances & mixtures) that are to be marketed as recyclates are required to be classified and labelled according to chemicals legislation.

Within the limits set by legal regulations, the waste hierarchy can be implemented in different ways. The identification of "optimal waste treatment" should balance the goals of "resource conservation" and "protection of health and the environment from toxic and ecotoxic risks". According to the KrWG, the expected emissions, the degree of conservation of natural resources, the energy to be used or recovered and the accumulation of pollutants in material cycles must be weighed against each other

Figure 8 shows the basic structure of a decision pathway for identifying the appropriate treatment, recycling and recovery routes, which respects the waste hierarchy and takes into account the inventory of "hazardous contents". The main questions at the respective substance-related decision points are explained below. This decision path explicitly addresses the conceptual sequence of pollutant-related issues. In waste management processes, the treatment paths are in many cases already largely pre-determined, mainly due to technical-economic considerations.

Therefore, in practice, some or all of these conceptual test steps are "skipped".

Figure 8: Decision tree for the choice of appropriate disposal paths for wastes containing hazardous substances



Source: own representation, Ökopol

The following list explains the questions at the decision points in the figure above.

a) For products that are suitable for preparation for re-use, it must be checked whether they contain substances that may not (no longer) be included due to a "new" restriction.

b) Before a possible preparation for re-use, it has to be checked whether a complete SVHC inventory of the product is available in order to fulfil the information obligations according to Article 3 REACH.

c) If necessary, legally prescribed, specific (pre-)treatment processes must be implemented for the waste stream (e.g. according to the End-of-Life Vehicles Ordinance). In addition, it must be checked whether a waste fraction contains substances that may not be recycled and must be separated respectively disposed of accordingly.

d) In the case of waste fractions that are in principle suitable for recycling and/or energy recovery, it must be examined whether they are suitable for "simple", mostly purely mechanical recycling processes without targeted substance separation. This would be the case if a) no hazardous substances are contained and therefore a wide use of the secondary materials is also possible or b) the hazardous substances contained are not SVHCs and the use of the secondary materials can be limited to uses in which (due to the exposure conditions existing there) no risks can arise.
If SVHC substances are contained in the waste stream and/or this is not known and the use of the secondary materials cannot be controlled, no mechanical recycling should take place.

e) If "simple recycling" is not appropriate, the next step is to assess whether a recycling process with targeted separation/destruction of the problematic substances is possible.

f) As a further option, it can be examined whether the waste fraction, with regard (also) to the pollutant inventory can be used for the production of standardised substitute fuels and thus for thermal recovery.

Considerations for the use of recyclates containing hazardous substances

In general, 3 cases are possible for the use of recyclates:

- Use in the same products from which they were obtained (closed loop);
  (hazardous) substances contained in the waste may also fulfil their function in the recycled product (e.g. plastic additives) and the new use of these substances can be avoided. In the closed loop it may also be acceptable to recycle SVHCs as long as this is not prohibited by a substance restriction and risks in this use are excluded.

- Use in products with low exposure potential for humans and the environment;
  If hazardous substances are present in the secondary material, their use is only acceptable in products from which they are hardly released and where no direct contact with the skin is possible, i.e. the exposure of the environment and/or humans is so low that no harmful effects are to be expected.

- Use without restriction of use;
  secondary materials that contain no or only "little hazardous" substances (which are also hardly ever released) can be used freely.

If it is unknown whether and which substances are or could be contained in a secondary material, a decision must be made between the goals of increasing recycling and producing safer materials. As a rule, safety is given priority, i.e. materials that would be suitable from a material

point of view are not recycled for precautionary reasons. In order to further utilise the recycling potentials here, additional assessment tools would have to be developed that are oriented towards the REACH chemical safety assessment and are practicable for the actors in the waste management. In the long term, the aim should also be to avoid using substances with certain properties (keyword: sustainable chemistry or "safe by design" approach) or to take disposal more into account when designing articles (extended producer responsibility).

Discussions in Expert Dialogue 3

In the following, some central points from the discussions of the expert dialogue are given:

- All levels of the waste hierarchy, including disposal, are important for a functioning circular economy.
- When deciding on the appropriate treatment process, the goals of resource efficiency and freedom from pollutants must be given equal consideration. In the discussion it became clear that on the one hand it is desired to evaluate the (complex) effects of a treatment and to make them the basis for decision-making. On the other hand, the decision support tools should be simple and easy to use. No solution could be found for this contradiction.
- Recycling of hazardous ingredients can make sense under "closed-loop". The prerequisite for this is that
  - the hazardous substances are comparable to those contained in the primary product in terms of concentration and matrix binding,
  - The use of the secondary products is comparable to that of the original products in terms of exposure risks to humans and the environment, and
  - this use of the substances has been identified as "safe" on the basis of a risk assessment.
- In practice, however, there are difficulties both in checking the conditions of use and in controlling the use of secondary materials.
- Currently, a comparatively large number of processes are running in parallel to strengthen the sustainable and circular economy with regard to the adaptation of the legal framework in chemicals, product and waste legislation. There is a risk that inconsistencies will arise due to a lack of cross-coordination and the limited resources of the respective actors, and that suboptimal frameworks will be adopted from an overarching perspective.
- A functioning circular economy already starts with a product design that uses chemicals that do not hinder recycling. This also requires (increased) cooperation between the actors.

Approaches derived from the expert dialogues to strengthen the risk management of hazardous substances in the interaction of chemicals and waste legislation

During the project work, it became clear that with regard to the interfaces between chemicals legislation and waste legislation, there are in fact two different areas to be discussed in which a need for action can be identified.

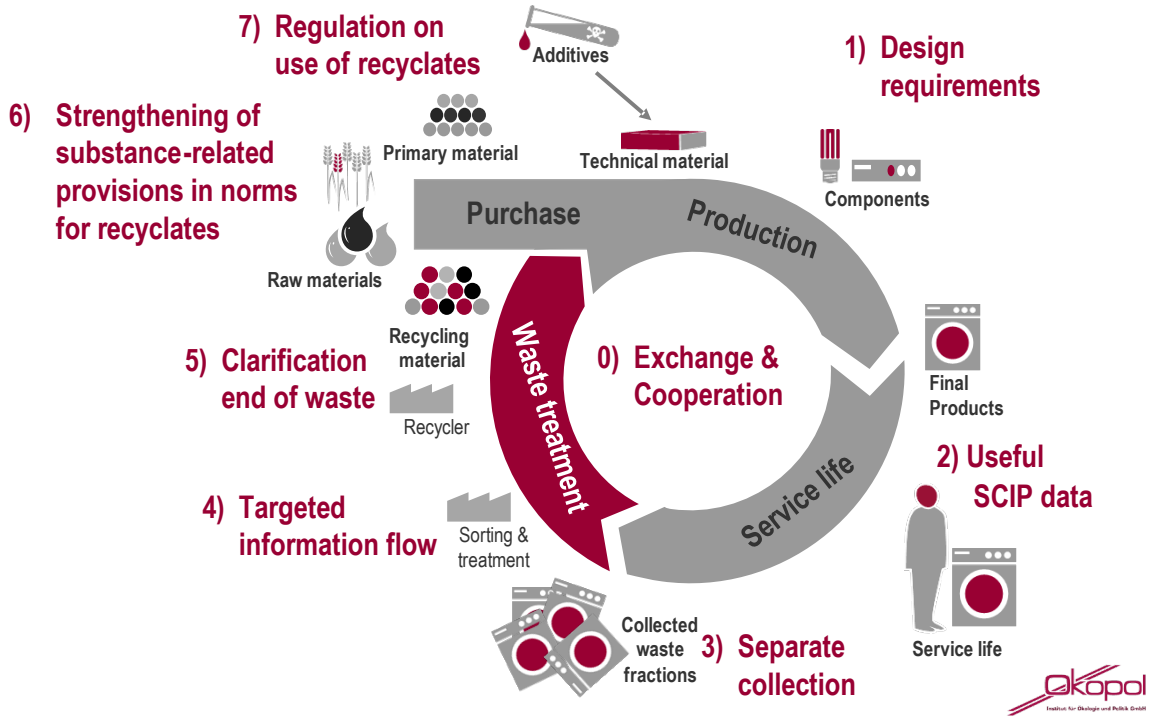
On the one hand, these are (A) the management and control of material risks that (can) arise in the circular economy, i.e. (waste) material flows, especially with regard to re-use in the 2nd use phase. On the other hand (B), it is about optimising the management of material-related risks within the waste phase.

(A) Improvements in the control of material risks during recycling and in the 2nd use phase

In the circular economy, the waste management processes are increasingly understood by the market actors as secondary supply chains and no longer, as in the past, primarily as downstream solutions for harmless disposal aligned with the needs of public welfare. As a result, the target qualities of the treatment and recycling processes and the corresponding quality assurance and communication routines are taking on a new significance. The design of the primary products - which in fact form the "raw material source" of the secondary supply chain - as well as other aspects, such as waste collection, take on a new significance in this change of perspective.

It is against this background, that the authors identified the eight starting points for measures to strengthen closed-loop recycling. These are based on the research and discussions in the overall project and are shown in the following diagram.

Figure 9: Approaches to strengthen the management of circular material flows with hazardous ingredients



Source: own representation, Ökopol

What is important to understand about these proposed measures is that

a) to be effective, the whole package of changes in all different areas is always needed,

b) the approaches - in line with the logic of a (secondary) supply chain - must be thought of and understood "from the end", i.e. from the 2nd use of the secondary materials.

The intended interaction of the proposed measures can be described in brief as follows:

To 7) “Regulation on use of recyclates”
A system of clear use restrictions and exemptions ensures that secondary materials, depending on their content of hazardous substances, only enter product uses and subsequent uses for which they have been assessed as "safe.

To 6) “Strengthening of substance-related provisions in norms for recyclates”
Norms and other standards for secondary materials contain clear definitions of pollutant classes that are linked to requirements for upstream quality assurance and to "safe" secondary uses. This builds confidence among recyclate users, thus supporting the emergence of a broad market demand for standardised secondary materials and providing clear targets for actors in the waste treatment and recycling chains.

To 5) “Clarification end of waste”
“Uniformly defined and enforced end-of-waste criteria require the implementation of (standardised) quality assurance steps and ensure that only substances and mixtures for which substance and safety information is made available that is appropriate for their classification and labelling to users in the second life cycle, regain product status.

To 4) “Targeted information flow”
The actors in waste management are supported in sorting and treating the waste fractions in a way that takes into account the content of hazardous substances by receiving directly evaluable "classifying" information on hazardous substances with the waste "objects". This specifically supplements the information of the pollutant-related planning and design of the treatment processes on the basis of available detailed information on the pollutant inventory of various waste "objects" and waste fractions (cf. approach 2).

To 3) “Separate collection”
Specifications for the separate collection of article waste that have been checked for their compatibility with the (also) hazardous material-related sorting efforts of waste treatment support the efficiency of these sorting efforts as well as the effectiveness of the subsequent quality assurance of the recycled materials

To 2) “Useful SCIP data”
Databases (such as an appropriately modified/expanded SCIP database) contain quantified and periodically updated information on the content of hazardous substances (especially SVHC as well as other regulated substances), for articles on the market and in the use phase. Evaluation options "across" product groups and/or waste collection groups provide waste management actors with a valid basis for the hazardous substance-related planning and design of sorting and treatment processes.

To 1) “Design requirements”
Voluntary and/or generally binding requirements for the eco-design of technical materials and articles lead to a review and thus also a limitation of the substances with hazardous properties used for the functionalisation of technical materials. Standardisation of the functionally required inventory of hazardous substances is carried out with a view to the use in product groups with subsequent common waste treatment. The resulting reduction and standardisation of the "expectable" inventory of hazardous substances is a central aspect with regard to the efficiency and effectiveness of all subsequent steps in the life cycle to increase the quantity of the recycling of "safe" material flows.

In order to achieve this overall picture, corresponding changes, some of them substantial, are necessary at the various starting points. These can be supported by corresponding measures of the legislator or other government agencies (corresponding possibilities are outlined in section 5.2.1 of the overall report). In parallel, however, it is indispensable that the binding and cooperative interaction of all market actors involved in the recycling of materials is strengthened. For this reason, there is the overarching proposal for starting point 0.

To 0) “Exchange and cooperation”
The market actors in the entire (multiple recursive) life cycle of a technical material form dialogue forums and working committees that serve the systematic exchange of information and the proper coordination of the design of measures. These measures support the overarching objective of establishing "safe" and at the same time quantitatively relevant, and thus resource-saving closed-loop management of the jointly "managed" material flow. It is important that all market actors involved make a clear commitment to this objective. This also includes the willingness to examine and, if necessary, implement substantial changes to existing material and product designs, existing business models and technical processes.

(B) Optimised management of material risks within waste management

The discussion on further optimising the management of material risks within waste management is closely linked to the efforts to strengthen the recycling of materials that (may) contain hazardous substances. The central question here is how the dynamically growing stock of facts and findings from the processes of substance and risk assessments under REACH can also be made accessible and effective for the actors in waste management.

In order to address the tendency towards imbalance in the management of material risks between the product and waste sectors, the authors have identified the following 4 starting points for possible improvement measures:

1. **Determination of "safe use conditions" in typical waste treatment processes within the framework of the registration of substances under REACH**
   The registrants of substances could be obliged to also consider the risks of waste-typical "uses" (processes) in the context of the chemical safety assessment, such as:

   - dust release during mechanical breaking of the material matrix (e.g. during shredding of materials in which the substance is introduced),
   - release of non-destroyed substances from combustion processes into the environment and
   - input to waters or air after migration and emission from a matrix

   to make the corresponding exposure scenarios and, if necessary, derive risk management measures available in a suitable form for the actors in waste management. This would substantially support waste management actors in reviewing and, if necessary, adapting their respective site- and process-related risk analyses.

2. **Implementation of waste stream-related query options in the SCIP database**
   In order to assess the inventory of hazardous substances anticipated for different waste fractions and to derive corresponding planning specifications for adapted sorting and treatment processes, waste management actors need both additional information in the database and adapted options for querying the data.
   The necessary additional information is in particular:

   - The specific proportions of the hazardous substances in the respective technical materials (in the articles),
   - Corresponding information on further (regulated) hazardous substances beyond SVHCs,
   - The typical waste codes under which subsequent disposal of the products is expected.

In order to take into account the sometimes relevant time lag between the marketing of the articles and their entry into the waste phase, the records in the SCIP database have to be updated periodically (e.g. with regard to SVHC or controlled substances that have been "newly" identified in the meantime).

The query options concern:

- Query across groups of similar articles ("product group queries"),
- Queries for possible waste fractions (via the waste codes of the expected disposal routes).

3. **Review of the mirror entries for wastes resulting from the use of articles in the list of waste**
   Due to the extremely high material heterogeneity of most wastes that were used as articles before they became waste, the classification of the corresponding waste fractions as hazardous or non-hazardous does not in fact provide any useful information for proper risk management in the further treatment of these waste fractions. Against this background, it seems sensible to systematically review the existence and non-existence of mirror entries in the area of waste to determine whether material flow control measures make this instrument necessary, or where such mirror entries can be dispensed to relieve the burden on the actors involved.
   The flow of information on hazardous substances and the performance of corresponding risk assessments for the various waste treatment processes must be ensured for all wastes, regardless of their waste classification. The approaches outlined here, among others, serve this purpose.
4. **Implementation of input-specific risk management measures**
   The operators of sorting, treatment and recycling facilities for waste systematically use the information on specific risks caused by the hazardous constituents (cf. approaches a and b above) of the waste streams handled by them for their risk analyses (hazard assessments, emission considerations) and, on this basis, regularly review the risk management measures they have established.

Zusammenfassung

Zielsetzung und Hintergrund des Vorhabens

Die in den letzten Jahrzehnten verabschiedeten Vorgaben im Chemikalien-, im Produkt- und im Abfallrecht werden sowohl in der Eigenverantwortung der Marktakteure als auch durch gesetzliche und untergesetzliche Regelungen umgesetzt. Da kontinuierlich neue Erkenntnisse zu den gefährlichen Eigenschaften von Stoffen sowie den möglichen Umwelt- und Gesundheitsrisiken ihrer Verwendung gewonnen werden, unterliegen diese Gesetzgebungen einem dynamischen Anpassungsprozess.

Die Verschiedenartigkeit der Rechtssystematiken, die Vielschichtigkeit der Anpassungsprozesse sowie inkonsistente Anforderungen und Kriterien bzgl. der Gefährlichkeit von Stoffen, Gemischen oder Erzeugnissen sowie von Abfällen führen nach Einschätzung vieler Marktakteure an den Schnittstellen des Abfall- und des Chemikalienrechtes zu Reibungsverlusten. Dadurch können wünschenswerte Marktentwicklungen[4] behindert, angestrebte Schutzniveaus nicht vollumfänglich erreicht werden oder Rechtsunsicherheiten für die beteiligten Akteure entstehen.

Das Vorhaben „Dialoge an der Schnittstelle zwischen Chemikalien- und Abfallrecht“ diente dazu, zwischen Fachexpert*innen aus der Unternehmenspraxis und der Verwaltung aus beiden Regelungsbereichen ein gemeinsames und fundiertes Verständnis über die Herausforderungen zu gewinnen, welche sich an den Schnittstellen des Chemikalien- und des Abfallrechts ergeben. Zudem sollten Lösungsansätze für diese Herausforderungen erarbeitet und mit den beteiligten Akteuren diskutiert werden. Dazu wurden drei Workshops mit Teilnehmenden aus der Wirtschaft und den Fachbehörden durchgeführt, die jeweils einen ausgewählten Teilaspekt der Schnittstelle in den Fokus genommen haben.

Für jeden dieser drei FachDialoge wurde der Status Quo des Themas in einem internen Arbeitsdokument aufbereitet. Auf dieser fachlichen Grundlage wurden die Programme gestaltet und Diskussionsfragen vorbereitet. Die Dialoge wurden pandemiebedingt als Online-Videokonferenzen mit je 15 bis 30 Teilnehmenden organisiert. Die freigegebenen Vorträge und die Dokumentationen der Dialoge können hier heruntergeladen werden.

Nachfolgend werden kurz

5. übergreifende fachliche Grundlagen zur Schnittstelle zwischen Chemikalien- und Abfallrecht,
6. die wechselseitige Verzahnung zwischen den beiden Rechtsbereichen (=> FachDialog 1),
7. das Problem der Informationsflüsse zu bedenklichen Stoffen zwischen Chemikalien- und Abfallbereich (=> FachDialog 2) sowie
8. Ansätze zur Stärkung der Abfallhierarchie bei Abfällen mit gefährlichen Inhaltsstoffen (=> FachDialog 3)

beschrieben.
Darauf aufbauend findet sich eine skizzenhafte Darstellung von Handlungsansätzen, die aus Sicht der Autor*innen im Zusammenspiel von Chemikalien- und Abfallrecht die Kreislaufführung von Materialien mit gefährlichen Inhaltsstoffen stärken könnten.

All diese Aspekte finden sich in umfassender ausgearbeiteter Form im Gesamtbericht.

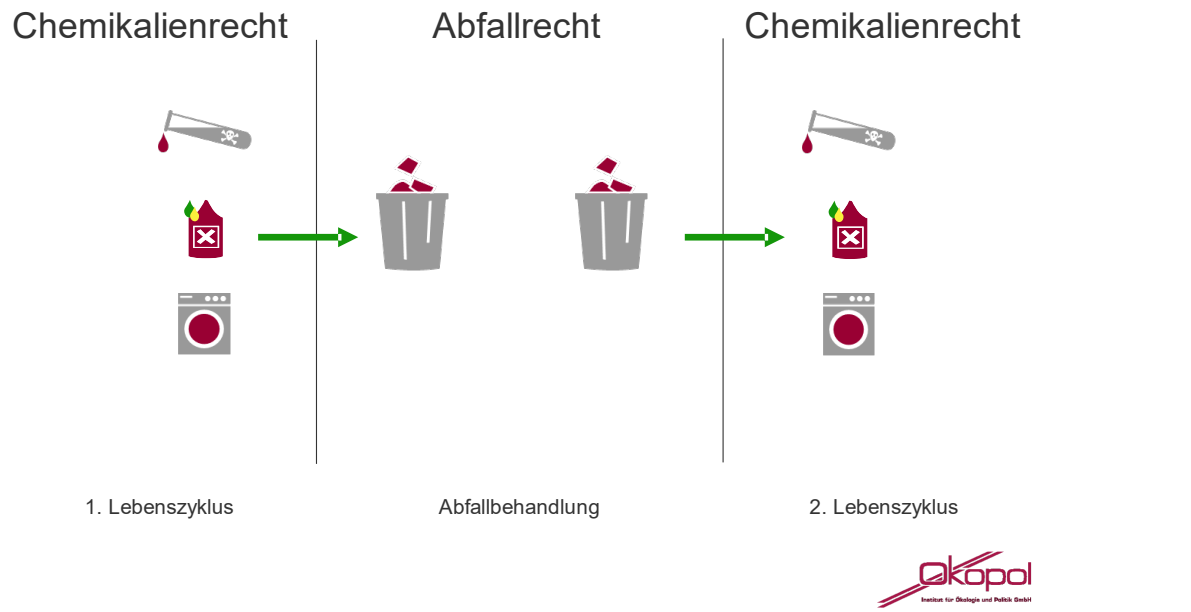
[4] Z.B. zur Etablierung von Kreislaufkonzepten im Rahmen der Kreislaufwirtschaft

Fachliche Grundlagen zum Verständnis der Schnittstellen zwischen Chemikalien- und Abfallrecht

Das Chemikalien- und das Abfallrecht sind klar voneinander getrennt und schließen einander aus, d.h. ein „Objekt" kann nur unter eines der beiden Regelungsbereiche fallen. Maßgeblich dafür, welches Recht anzuwenden ist, ist die Definition von Abfall (§ 3 (1) des Kreislaufwirtschaftsgesetzes (KrWG)): *„[…] Stoff oder Gegenstand, dessen sich sein Besitzer entledigt, entledigen will oder entledigen muss"*.

Wird ein Abfall ordnungsgemäß und schadlos verwertet und endet die Abfalleigenschaft, so greifen automatisch wieder die Anforderungen des Chemikalienrechtes (Figure 1) bzw. auch andere produktbezogene Regelungen. In einer Kreislaufwirtschaft können Stoffe und Gegenstände mehrfach zwischen dem Chemikalienrecht und dem Abfallrecht wechseln.

Abbildung 10: Trennung zwischen Chemikalienrecht und Abfallrecht



Quelle: eigene Darstellung, Ökopol

Regelungsgegenstände im Chemikalien- und im Abfallrecht

Die Regelungsgegenstände im Chemikalien- und Abfallrecht unterscheiden sich grundlegend. Das Chemikalienrecht unterscheidet drei jeweils eindeutig definierte „Objekte": Stoff, Gemisch und Erzeugnis für die entsprechend dieser Definitionen unterschiedliche Rechtsfolgen bestehen. Im Gegensatz dazu ist der definierte Regelungsgegenstand im Abfallrecht der Abfall. Der Abfallbegriff wird dabei nicht weiter differenziert. Er erfasst materiell aber in gleichem Maße die im Chemikalienrecht differenzierteren „Objekte" Stoffe Gemische und Erzeugnisse. Eine weitere Differenzierung erfolgt im Abfallrecht durch die Abfallarten und die Abfallherkunft in Form der Abfallschlüssel.

Stoffe, Gemische und Erzeugnisse

Die rechtlichen Anforderungen an Stoffe, Gemische und Erzeugnisse sind in der Verordnung zur Registrierung, Bewertung, Zulassung und Beschränkung von Chemikalien (REACH) sowie der Verordnung zur Einstufung, Kennzeichnung und Verpackungen von Stoffen und Gemischen (CLP) festgeschrieben.

- Stoffe sind ab einer Herstellungs-/Importmenge von 1 Tonne pro Jahr und Hersteller bzw. Importeur zu registrieren. Das Recycling ist chemikalienrechtlich eine Herstellung,

weswegen Recycler ebenfalls registrierungspflichtig sind. Ausnahmen sind unter bestimmten Bedingungen möglich.
Zur Registrierung sind Informationen über die Eigenschaften und Verwendungen von Stoffen bereitzustellen. Die Daten über die Stoffeigenschaften werden genutzt, um gemäß der CLP-Methodik zu identifizieren, ob und welche Gefahrenklassen und -kategorien einem Stoff CLP zuzuordnen sind (=> „chemikalienrechtliche Einstufung“).

- Gemische müssen nicht registriert werden. Sie sind jedoch hinsichtlich ihrer gefährlichen Eigenschaften zu prüfen und gemäß CLP einzustufen.
- Für eingestufte Stoffe und Gemische sind Sicherheitsdatenblätter (SDBs) mit entsprechenden Informationen und Hinweisen zur sicheren Handhabung zu erstellen und an die Kund*innen weiterzugeben.
- Für Erzeugnisse gibt es mit der Ausnahme einer Kommunikationspflicht über enthaltene, besonders besorgniserregende Stoffe (SVHC) – in Konzentrationen von > 0,1% – keine chemikalienrechtlich definierten Anforderungen.

Abfälle

Die Erzeuger und Besitzer von Abfällen sind gemäß KrWG verpflichtet Abfälle so zu verwerten, dass keine Schädigungen von Umwelt und Gesundheit auftreten und – falls eine Verwertung nicht möglich ist – diese schadlos zu beseitigen. Abfälle werden gemäß dem Verfahren der Abfallverzeichnisverordnung (AVV) eingestuft (=> „abfallrechtliche Einstufung“). Wenn in diesem Verfahren Abfälle mit einem Spiegeleintrag auf ihre gefahrenrelevanten Eigenschaften untersucht werden, wird die Einstufung und Kennzeichnung von Stoffen und Gemischen aus dem Chemikalienrecht genutzt. Da sich Methoden und Kriterien zur Einstufung von im Chemikalien- und Abfallrecht in Bezug auf einzelne Aspekte unterscheiden, sind beide Systeme nur bedingt vergleichbar.

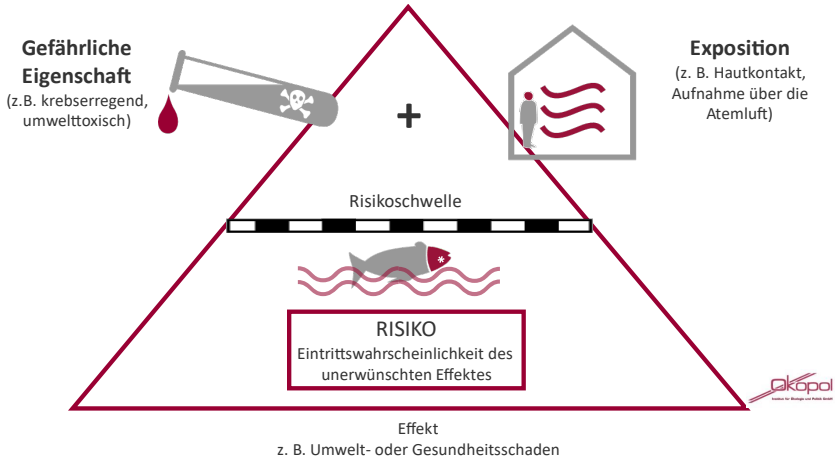
Gefährliche Stoffe in Materialkreisläufen und Produkten

Viele Chemikalien werden im Herstellungsprozess von Materialien oder Produkten absichtlich zugefügt, um bestimmte Funktionalitäten zu erzeugen. Daneben können sie auch als Verunreinigung aus Rohmaterialien, Prozesshilfsmitteln oder durch (unerwünschte) chemische Reaktionen in die Material- und Produktströme gelangen. Während die Hersteller die Identität und Eigenschaften absichtlich verwendeter Stoffe kennen, sind ihnen die Identität und Mengenanteile von Verunreinigungen in der Praxis vielfach nicht exakt bekannt.

Als gefährlich eingestufte Inhaltsstoffe können aus den Produktabfallströmen in der Abfallbehandlung abgetrennt und/oder zerstört oder in Sekundärmaterialien verschleppt werden und nachfolgend eine neue Lebensphase beginnen. Somit ist auch die Verwendung von Sekundärmaterialien ein möglicher Eintragspfad für gefährliche Stoffe in die Produkte auf dem Markt.

Zur Prüfung, ob gefährliche Stoffe in Materialien sowie in Produkten die Umwelt oder die Gesundheit schädigen können, wird im Chemikalienrecht das Instrument der Risikobewertung genutzt. Hierbei wird die Konzentration/Dosis oberhalb derer schädliche Effekte für Mensch und/oder Umwelt erwartet werden mit der Konzentration/Dosis verglichen, der Mensch und Umwelt durch die Verwendung des Stoffes ausgesetzt sind (Exposition).

Abbildung 11: Einflussfaktoren und Begrifflichkeiten bei der stoffbezogenen Risikoermittlung



Quelle: eigene Darstellung, Ökopol

Zeigt eine Risikobewertung, dass eine bestimmte Verwendung „nicht sicher“ ist (Risiken für Mensch und/oder Umwelt), so darf diese Verwendung nicht registriert werden und ist somit nicht erlaubt. Produkthersteller und -importeure sind gemäß Lebensmittel- und Bedarfsgegenständegesetz verpflichtet zu prüfen und sicherzustellen, dass den Nutzer*innen dieser Produkte bei bestimmungsgemäßer Verwendung keine Risiken entstehen.

Grundsätzlich sind auch die Akteure der Abfallbehandlungskette dazu angehalten, basierend auf einer Erwägung möglicher Schädigungen für Mensch und Umwelt zu entscheiden, welche Behandlungsverfahren für einen Abfallstrom geeignet sind.

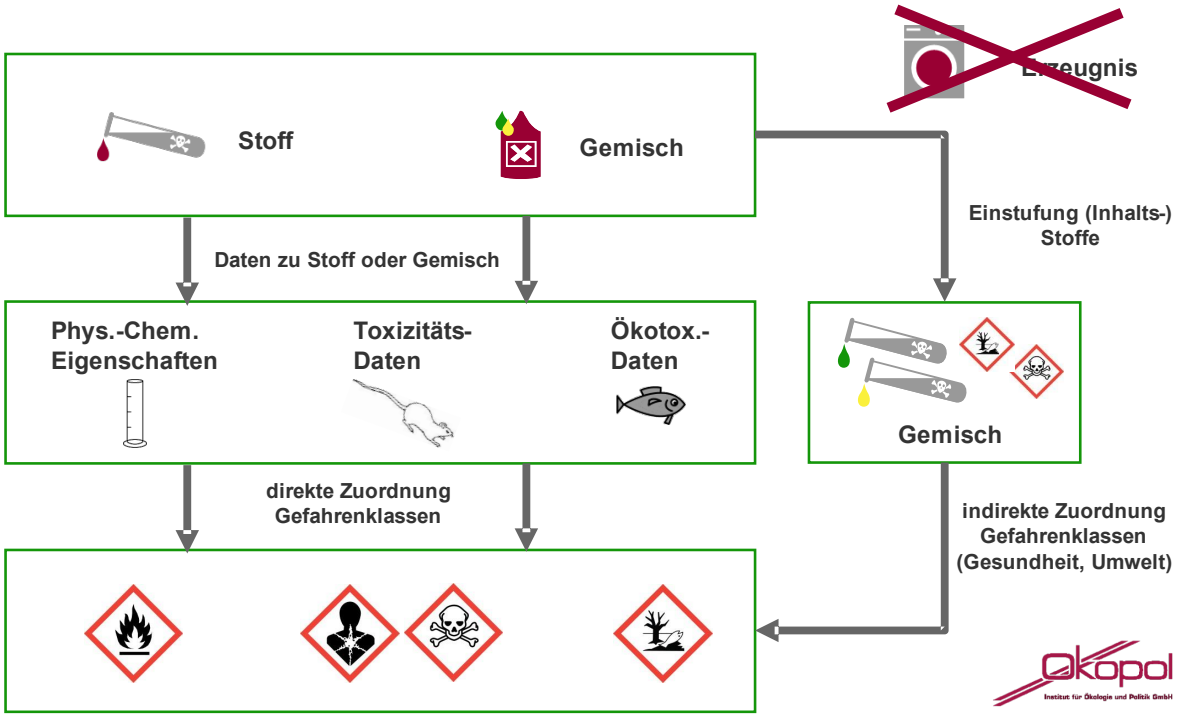
Verzahnung zwischen Chemikalien- und Abfallrecht (=> FachDialog 1)

An diesem FachDialog haben ausschließlich Vertreter*innen aus Behörden teilgenommen. Im Rahmen des Dialogthemas war es das Ziel, rechtliche Unklarheiten und bestehende Unterschiede an der Schnittstelle zwischen Chemikalien- und Abfallrecht zu diskutieren. Hierzu gehörte insbesondere die Diskussion über die Verfahren zur Einstufung als „gefährlich“ im Chemikalienrecht und im Abfallrecht und die dadurch ausgelösten Rechtsfolgen.

Vorgehen bei der chemikalienrechtlichen Einstufung

Zur Ermittlung, welche Gefahrenklassen und -kategorien ein Stoff erfüllt, werden Daten aus Tests und weiteren Verfahren mit den Kriterien der CLP-Verordnung verglichen. Gemische werden anhand der Einstufungen und Konzentrationen ihrer Inhaltsstoffe eingestuft und/oder basierend auf Tests mit dem Gemisch. Erzeugnisse werden nicht eingestuft. Die Einstufung ist jeweils von den Inverkehrbringern vorzunehmen (=> „Selbsteinstufung“). Die Behörden können in einem EU-Verfahren Stoffe auch einheitlich einstufen (=> „Harmonisierte Einstufung“).

Abbildung 12: System der Einstufung und Kennzeichnung nach CLP-Verordnung



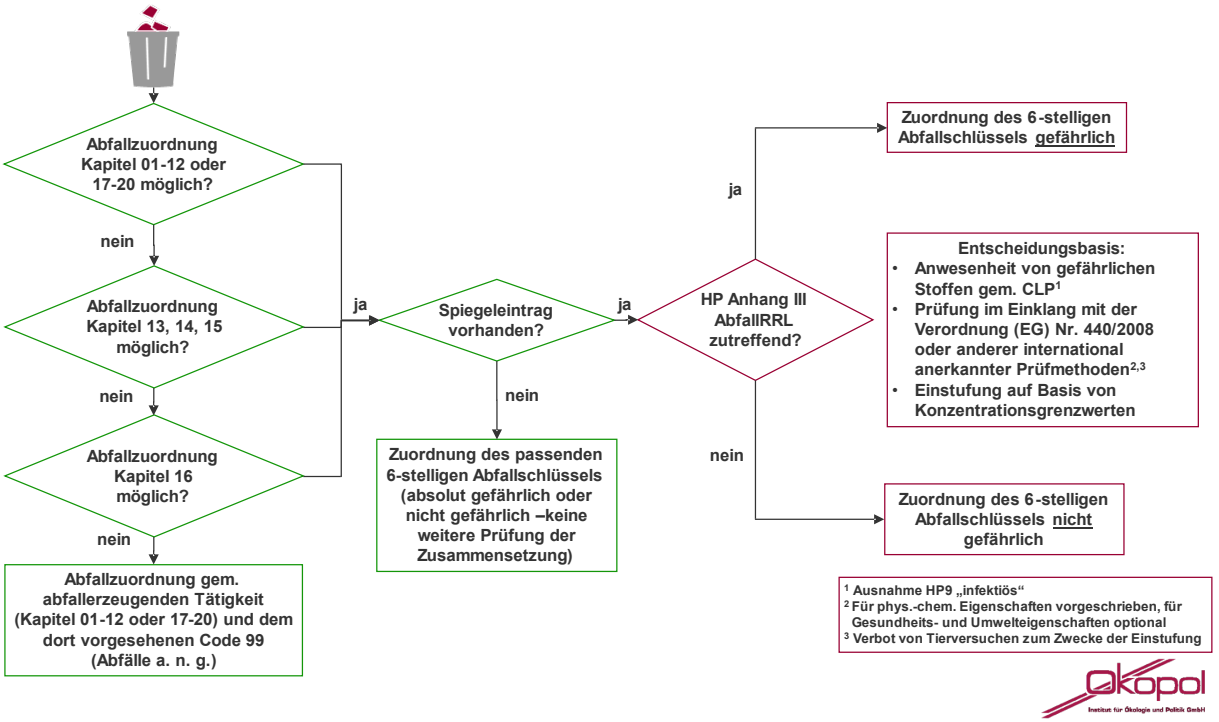
Quelle: eigene Darstellung, Ökopol

Vorgehen bei der abfallrechtlichen Einstufung

Abfälle werden gemäß den Vorgaben der Abfallverzeichnisverordnung (AVV) eingestuft, indem ein 6-stelliger Abfallschlüssel zugewiesen wird. Das Abfallverzeichnis ist in 20 Kapitel zur Abfallherkunft unterteilt. Diese sind in Gruppen untergliedert und weiterhin bzgl. der Abfallarten konkretisiert. Abfallschlüssel mit „Sternchen“ kennzeichnen Abfälle, die „gefährliche Inhaltsstoffe“ enthalten. Sie sind vielfach sogenannte „Spiegeleinträge“ zu ansonsten weitgehend gleichartigen Abfallarten Es existieren in verschiedenen Herkunftsbereichen aber auch Abfallschlüssel mit Sternchen, die in ihrer Bezeichnung bereits konkret gefährliche Stoffe benennen, z. B. Quecksilber, Polychlorierte Biphenyle (PCB) etc.

Die Abfallerzeuger sind verpflichtet, ihren Abfällen einem Abfallschlüssel zuzuordnen. Sie greifen dafür meist auf die Expertise von Entsorgungsunternehmen und/ oder der Vollzugsbehörden zurück. Zudem existieren Leitlinien zur Abfalleinstufung. Wird ein Abfall aufgrund seiner Herkunft einem Abfallschlüssel ohne Spiegeleintrag zugeordnet, ist mit dieser Zuordnung zum Herkunftsbereich auch bereits festgelegt, dass der Abfall „nicht gefährlich“ bzw. „gefährlich“ ist. Wenn Spiegeleinträge existieren, ist anhand der sogenannten „HP-Kriterien“ unter Bezugnahme auf die Inhaltsstoffe und ihre Konzentration im Abfall zu prüfen und zu entscheiden, ob er gefährlich ist. Die folgende Grafik zeigt diese Vorgehensweise im schematischen Überblick.

Abbildung 13: Entscheidungsbaum zur Abfalleinstufung



Quelle: eigene Darstellung, Ökopol

Die Auswahl eines Abfallschlüssels bei Spiegeleinträgen erfolgt auf Basis der Inhaltsstoffe in Anlehnung an die chemikalienrechtliche Einstufung von Gemischen gemäß Anhang III der EU-AbfRRL. Dieser Anhang definiert die Kriterien für die gefahrenrelevanten Eigenschaften (hazardous properties (HP)), welche denen im Chemikalienrecht ähneln. Zusätzlich sind nach AVV Abfälle, die bestimmte POP oberhalb definierter Konzentrationsschwellen enthalten, ebenfalls als gefährlich einzustufen.

Bei Abfällen, die bei der Verwendung von Stoffen oder Gemischen entstehen, d.h. bei vielen der gewerblich anfallen Produktionsabfälle, lassen sich die für die Abfalleinstufung (gefährlich oder nicht-gefährlich) relevanten Stoffeigenschaften oft aus den vorliegenden SDB entnehmen.

Werden hingegen Erzeugnisse zu Abfällen so fehlen meist die entsprechenden Informationen über den Gehalt an gefährlichen Stoffen. Häufig wird von den Marktakteuren angenommen, dass Stoffe in Erzeugnissen keine Risiken erzeugen können, da die Produkte ja „sicher“ im Markt sind. Diese Annahme ist allerdings falsch, da bei der abfallrechtlichen Einstufung lediglich auf den Gehalt eines „gefährlichen“ Inhaltsstoffes abgestellt wird.

Rechtsfolgen einer Einstufung von Stoffen und Gemischen oder Abfällen als „gefährlich“

Werden Stoffe oder Gemische als gefährlich eingestuft, können je nach Gefahrenklasse, verschiedene Rechtsfolgen ausgelöst werden, u.a.:

- Verpflichtung zur Durchführung einer Expositionsabschätzung und Risikobewertung unter REACH sowie zur Bereitstellung von Sicherheitsdatenblättern.
- Beschränkung der Verwendung in bestimmten (chemischen) Produkten und/oder Zulassungspflicht für diese Verwendungen.

- Pflicht zur Berücksichtigung bei Gefährdungsbeurteilungen am Arbeitsplatz und ggf. Umsetzung von Maßnahmen zum Schutz von Beschäftigten vor chemikalienbedingten Risiken
- Pflicht zur Berücksichtigung bei der Genehmigung von Anlagen sowie ggf. bei Notfallplänen und der Lagerung (Anlagensicherheit)

Die Einstufung eines Abfalls als gefährlich löst zusätzliche rechtliche Anforderungen aus, u.a.:

- Dokumentationspflichten bzgl. der Abfallbehandlung (abfallrechtliche Überwachung durch das Begleitscheinverfahren),
- Einschränkung zulässiger Abfalloperationen in Bezug auf Vermischung und Getrennthaltung,
- Pflicht zur Aufnahme in die Genehmigung der Anlagen bei Anlagen, die diese Abfälle behandeln, sowie ggf. ergänzende Anforderungen an die Anlagengestaltung.

Ende der Abfalleigenschaft, Beginn der Produkteigenschaft

Sowohl der Beginn als auch das Ende der Abfalleigenschaft sind nicht eindeutig definiert und somit „Graubereiche“, die in der Praxis Klärungsbedarfe aufwerfen. Auf EU-Ebene wurden für einige Materialströme Kriterien für das Abfallende entwickelt. Für weitere Materialströme (z. B. Kunststoffe oder Baustoffmassen) fehlen jedoch harmonisierte Kriterien für das Ende der Abfalleigenschaft, womit die Entscheidung darüber, ob ein Objekt seine Abfalleigenschaft verliert, der Selbsteinschätzung der Abfall- und Recyclingakteure überlassen bleibt.

Zentrale Diskussionspunkte des FachDialoges 1

In der Diskussion beim FachDialog 1 wurden die folgenden Punkte hervorgehoben:

- Veränderungen bei der Einstufung von Stoffen wirken sich z.T. direkt auf die Einstufung von Abfällen als „gefährlich“ aus. Aus den daraus resultierenden Rechtsfolgen können für die Abfallakteure signifikante ökonomische und praktische Belastungen entstehen.
- Besonders für langlebige Produkte fehlen Informationen zum Gehalt an gefährlichen Stoffen in der Abfallphase. Ändern sich chemikalienrechtliche Einstufungen der Inhaltsstoffe, kann sich dadurch auch die abfallrechtliche Einstufung in diesem Zeitraum verändern.
- Stoffe/Gemische dürfen nach dem Ende ihrer Abfalleigenschaft keine schädlichen Auswirkungen auf den Menschen oder die Umwelt haben. Aufgrund der unzureichenden Informationslage zur Zusammensetzung von „post-consumer“-Abfällen bestehen für Recyclingunternehmen diesbezüglich erhebliche Unsicherheiten bezüglich der Sekundärprodukte und -Materialien.
- Die Möglichkeiten aus dem Abfallbereich heraus auf die Gestaltung von Produkten einzuwirken, um später bei deren Entsorgung Problemen vorzubeugen, sind bislang sehr begrenzt.
- Das als veraltet angesehene Abfallverzeichnis sowie die beim Workshop kritisierte Anwendung von Testmethoden für die Überprüfung von HP-Kriterien, sollten auf EU-Ebene überprüft und überarbeitet werden. Für die Zeit bis zu neuen Regelungen sollten (nationale) Übergangslösungen erarbeitet werden.

- Da Abfälle in der Praxis zumeist anhand der Abfallherkunft eingestuft werden, relativieren sich im Abfallbereich die Folgen der Dynamik der Einstufungen von Chemikalien (die zu Abfallinhaltsstoffen werden). In diesem Bereich gibt es vielfach gar keine Spiegeleinträge.
- Die Dualität der Abfalleinstufung (gefährlich/nicht gefährlich) kann den Informationsbedarf z. B. der Recyclingakteure nicht befriedigen. Ein differenzierterer Umgang mit komplexen Stoffinformationen wurde als zentrale Voraussetzung für eine funktionierende Kreislaufwirtschaft angesehen

Informationsflüsse zu bedenklichen Stoffen zwischen Chemikalien- und Abfallbereich (=> FachDialog 2)

Im 2. FachDialog sollte die rechtliche Ausgangslage und praktische Herausforderungen für einen Informationsfluss über bedenkliche Stoffe in Produkten bzgl. der Ermöglichung einer Kreislaufwirtschaft diskutiert werden. Ziel war es, Lösungsansätze zu entwickeln, wie der Informationsfluss verbessert werden könnte.

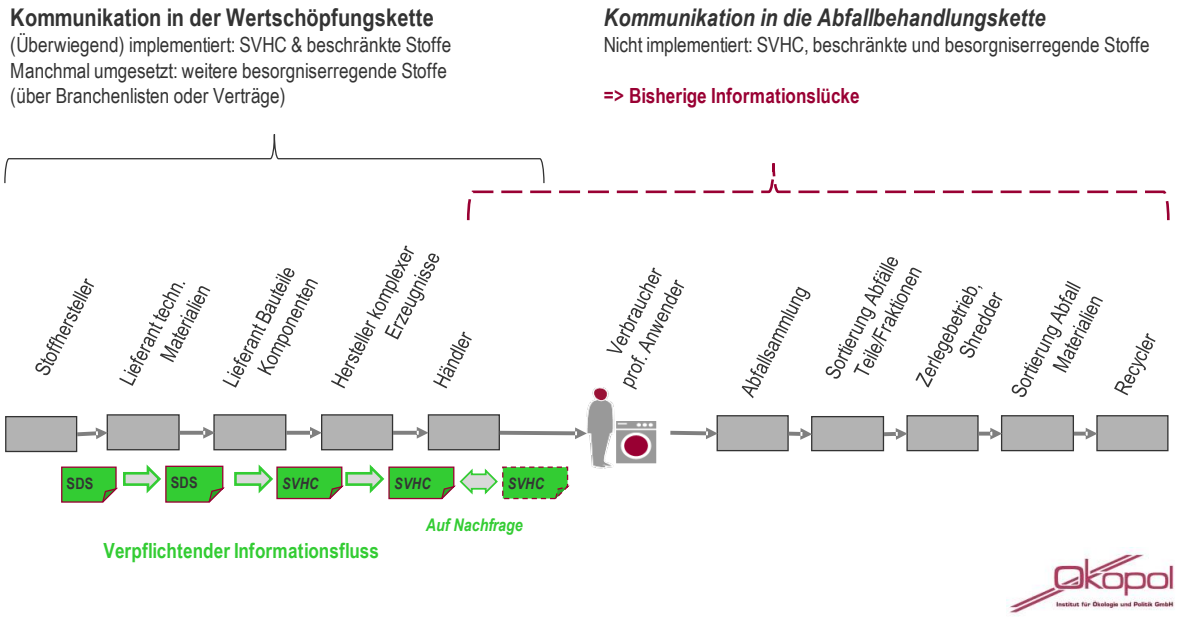
Die Marktakteure brauchen Informationen über gefährliche Stoffe in Produkten, um zu prüfen, welche Risikomanagementmaßnahmen entlang des gesamten Lebenszyklus sachgerecht sind. Innerhalb der primären Lieferketten gibt es sowohl rechtliche Anforderungen an die Informationsweitergabe als auch darüberhinausgehende Regelungen und Instrumente. Auch innerhalb der Abfallphase gibt es für Abfälle, die als „gefährlich" klassifiziert wurden, ein etabliertes System der Informationsweitergabe.

Dennoch ist die zentrale Herausforderung für die Akteure der Abfallwirtschaft, dass konkrete und belastbare Informationen über den Gehalt an gefährlichen Stoffen in Abfällen, welche aus Objekten bestehen die vormals Erzeugnisse waren, sowie die Beurteilung resultierender Risiken für Mensch und Umwelt bei ihrer Behandlung fehlen. Dadurch wird das Risikomanagement in der Abfallbehandlung erschwert und es können nur mit hohem Aufwand „informierte" Sortier- und Behandlungsentscheidungen getroffen werden, um gezielt (sichere) Sekundärmaterialien herzustellen.

Informationspflichten im Chemikalienrecht

Für als gefährlich eingestufte Stoffe und Gemische ist dem nachgeschalteten Anwender (Kund*in) ein Sicherheitsdatenblatt (SDB) zur Verfügung zu stellen. Dieses muss Informationen über die gefährlichen Eigenschaften der Chemikalien enthalten sowie Hinweise zur sicheren Verwendung und zur Entsorgung, einschließlich anwendbarer Abfallschlüssel. Der Informationsfluss durch das SDB endet, wenn ein Stoff/Gemisch zu einem Erzeugnis wird. Für Erzeugnisse besteht lediglich eine Pflicht, die Kund*innen darüber zu informieren, ob SVHCs in einer Konzentration > 0,1 Gew.-% im Erzeugnis enthalten sind (Art. 33 REACH). Die Kommunikation über gefährliche Stoffe endet gänzlich mit der Nutzungsphase der Produkte. Die resultierende „Informationslücke" zu gefährlichen Stoffen in Erzeugnissen und in den Abfallströmen wird in Figure 5 grafisch verdeutlicht.

Abbildung 14: Bisherige Situation der verpflichtenden Informationsanforderungen an bedenkliche Stoffe in Erzeugnissen



Quelle: eigene Darstellung, Ökopol

Informationspflichten im Abfallrecht

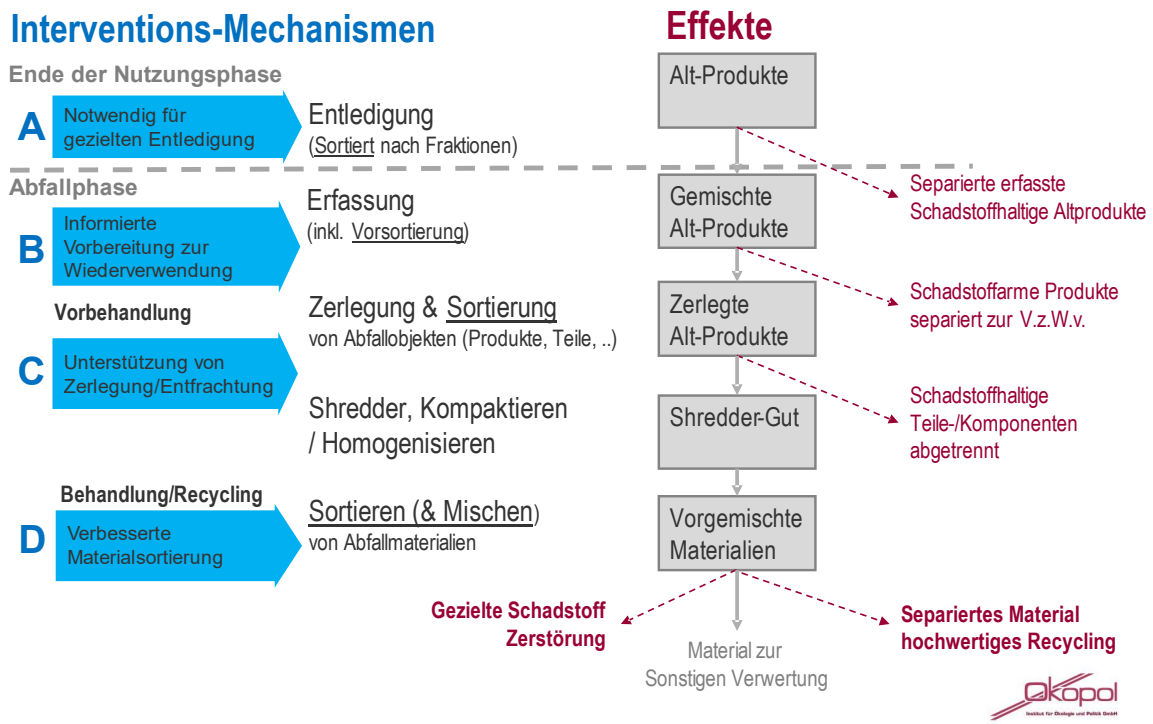
Nach § 16f ChemG sind Lieferanten von Erzeugnissen verpflichtet, Informationen über SVHC, die in ihren Produkten in Konzentrationen oberhalb von 0,1 Gew.-% enthalten sind, an eine öffentlich zugängliche Datenbank der ECHA (SCIP) zu melden. Bisher fehlen Möglichkeiten für die Akteure der Abfallwirtschaft, diese Informationen in einer für sie hilfreichen Form und Aggregation zu extrahieren. Zudem fehlen einige, für die Abfallakteure wichtige Informationen, wie z. B. die reale SVHC-Konzentration oder auch der Gehalt weiterer regulierter nicht-SVHC-Stoffe. Die SCIP-Datenbank kann daher die „Informationslücke" zwar verkleinern, aber nicht schließen. Auch die im Rahmen der Produktverantwortung etablierten Kommunikationspflichten (z. B. Altfahrzeugverordnung) und freiwillige Instrumente können die Informationslücke (für Abfälle aus Objekten die zuvor Erzeugnisse waren) nur geringfügig verkleinern.

Bedarf an Information über Stoffe in Produkten/Abfällen zur Verbesserung der Kreislaufwirtschaft

In einer Studie für die EU-Kommission[5] wurde gezeigt, dass zusätzliche Informationen über bedenkliche Stoffe in Erzeugnissen die Abfallbehandlung und das Recycling insbesondere dann verbessern können, wenn sie für die Sortierschritte in den abfallwirtschaftlichen Behandlungsketten verfügbar werden. Es wurden vier **Interventions-Mechanismen** für ein verbessertes und „informiertes Sortieren" identifiziert.

[5] Ökopol (2020): "Information Flows on substances of concern in products from supply chains to waste operators, Final report", für die Generaldirektion Binnenmarkt, Industrie, Unternehmertum und KMU. (InfoFlow-Studie).

Abbildung 15: Interventions-Mechanismen zur verbesserten Kreislaufführung durch zusätzliche Stoffinformationen



Quelle: eigene Darstellung, Ökopol

Diese vier Interventions-Mechanismen werden nachfolgend skizzenhaft erläutert:

- **Mechanismus A:** Altprodukte werden, bevor sie zu Abfall werden, (vor-)sortiert und gezielt entsorgt. Beispiel: Baufirmen sortieren HBCD-freie Dämmplatten für ein EPS-Recycling aus.
- **Mechanismus B**: Produkte, für die Detailinformation zum Gehalt gefährlicher Stoffe verfügbar ist, werden markiert und so einfach für die Vorbereitung zur Wiederverwendung selektiert. Beispiel: Ein Label an Mobiltelefonen zeigt an, ob genug Informationen für ein erneutes Inverkehrbringen vorhanden sind. Im weiteren Prozess werden die Detaildaten genutzt, um ein gesetzeskonformes wieder Inverkehrbringen sicherzustellen.
- **Mechanismus C:** Schnell verfügbare Informationen über den Gehalt an bedenklichen Stoffen in (Teil-)Produkten erlauben deren schnelle Separierung vom Abfallstrom. Beispiel: PFAS-haltige Textilien werden von PFAS-freien Textilien getrennt. So werden die Materialströme, die dem weiteren Recycling zugeführt werden, von Schadstoffen entfrachtet.
- **Mechanismus D:** Zusätzliche Stoffinformation können sowohl das Sortieren als auch das aus technischen Gründen z. T. notwendige gezielte Verschneiden von Materialströmen aus unterschiedlichen Herkunftsbereichen unterstützen und damit zu besser definierten Inputfraktionen in die eigentlichen Materialrecyclingprozesse führen, z. B. im Kunststoffrecycling.

Nach Aussagen der Betreiber von Entsorgungsanlagen sind Informationen über bedenkliche Stoffe in Abfällen insbesondere dann hilfreich, wenn sie aggregiert sind und sich auf:

- Stoffgruppen statt auf Einzelstoffe beziehen (z. B. auf alle bromierten Flammschutzmittel),
- die bei Zerlege- und Trennprozessen üblicherweise anfallenden Baugruppen/Teile,
- die realen Gehalte und Mengenanteile in Geräten/Baugruppen oder Materialien

beziehen und sie unter den Bedingungen der (Sortier-)Prozesse gut auszulesen und zu interpretieren sind.

Lösungsansätze zur Stärkung der Informationsflüsse

Lösungsansätze zur Übertragung von Stoffinformationen von den Akteuren der primären Lieferkette zu denen der Abfallbehandlungskette müssen zwei Herausforderungen überwinden:

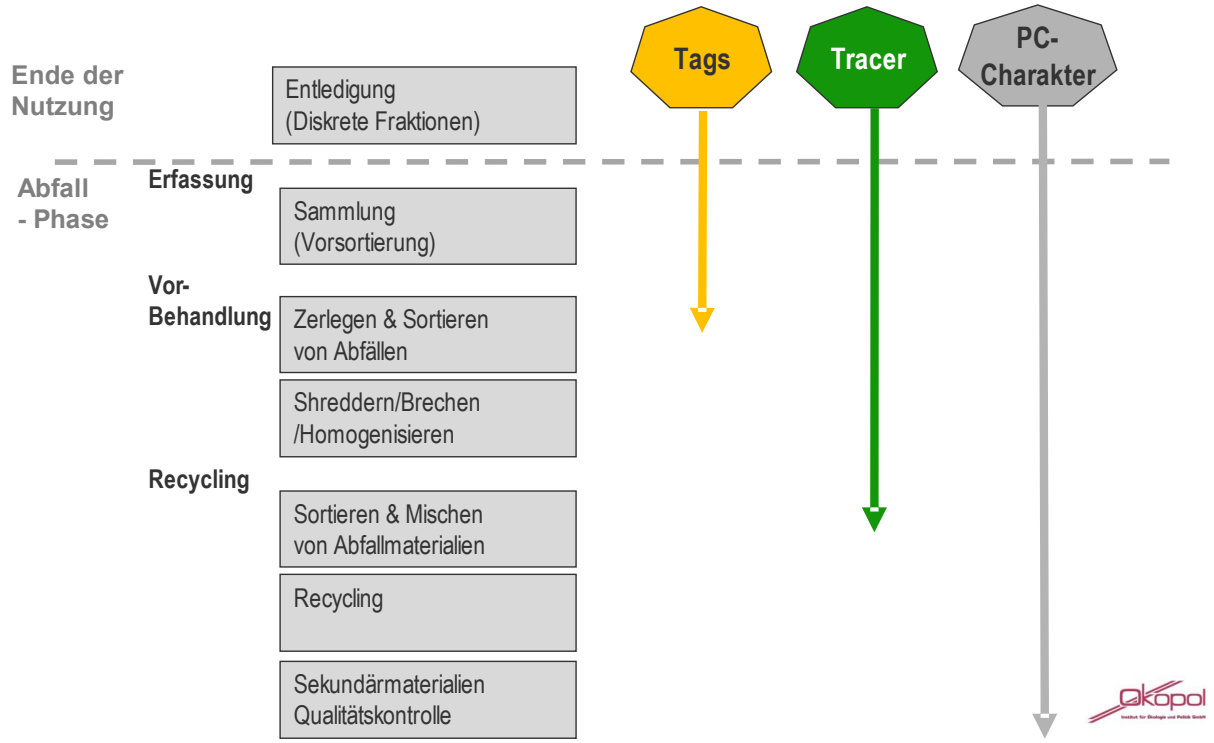
- Zwischen dem Sender der Information in der primären Lieferkette und dem Empfänger in der Abfallbehandlung gibt es keine eindeutig (vorab) festgelegte Beziehung.
- Die Nutzungsdauer kann zwischen wenigen Wochen/Tagen bis zu mehr als 50 Jahren betragen.

Es können grundsätzlich vier Ansätze zum Informationstransfer unterschieden werden. Bei einem **Flag** werden die zu übertragenden Informationen direkt auf/mit dem jeweiligen Informationsträger transportiert. Ein **Unique Identifier** übermittelt „lediglich“ die eindeutige Identität des Gegenstandes, z. B. in Form einer Seriennummer. Anhand der Identität kann in einer verbundenen Datenbank die Detailinformation zum Produkt ausgelesen werden. Ein weiterer Ansatz ist die Messung von Stoffen in Materialien anhand ihrer **physikalisch-chemischen (PC)- Eigenschaften.** Darüber hinaus kann das Stoffinventar eines Produktes in einer **gesonderten Dokumentation** abgelegt werden, die mit dem Produkt nur indirekt verbunden ist, z. B. in einem Gebäudepass.

Physikalisch können die Träger der Informationen sog. **Tags** sein, die auf oder in der Oberfläche eines Erzeugnisses angebracht werden. Die Information kann direkt „lesbar“ (Label, Symbole etc.) oder „maschinenlesbar“ und verschlüsselt sein (z.B. QR-Codes, Hologramme, RFID). **Tracer** sind Substanzen, die in eine Materialmatrix eingebracht und leicht gemessen werden können. Sie können (bisher) lediglich „binäre“ Informationen übertragen. Tracer „konkurrieren“ mit der direkten Messung von Stoffen in Materialien anhand ihrer Eigenschaften.

Die Eignung der Informationsträger für den Informationstransfer in die Abfallbehandlungskette ist davon abhängig, welchen Prozess sie informieren sollen bzw. wie weit sie ohne Zerstörung (und damit dem Verlust der Information) in die typischen Behandlungsprozesse eindringen können („Eindringtiefe“).

Abbildung 16: Eindringtiefe von Informationsträgern in die Abfallbehandlungsketten



Quelle: eigene Darstellung, Ökopol

Tracer können selbst rauen Bedingungen während der Produktnutzung und der Abfallbehandlung widerstehen. Sie erreichen daher auch die späten Schritte in der Abfallbehandlungskette bis zum eigentlichen Materialrecycling. Tags sind deutlich empfindlicher und können bereits bei „unsachgemäßer“ Nutzung oder durch „physikalischen“ Stress während der Abfallbehandlung zerstört werden. Sie eignen sich dazu, die früheren Schritte in der Abfallbehandlung zu informieren.

Ein Transport von komplexen (Stoff-)Informationen bis ans Ende der Recyclingkette (hergestellte Recyclingmaterialien) ist derzeit mit keiner dieser Techniken möglich. Allerdings können die PC-Eigenschaften eines Sekundärmaterials analysiert und so Informationen über den Gehalt bedenklicher Stoffe gewonnen werden.

Diskussionen im Dialog-Workshop 2

Die folgenden zentralen Punkte wurden beim Dialog-Workshop diskutiert und als Einschätzung der teilnehmenden Expertinnen und Experten festgehalten.

- Damit die Ziele des Green Deal bzgl. der (schadstofffreien) Kreislaufwirtschaft erreicht werden können, brauchen die Akteure des Abfallsektors aussagekräftige Informationen über gefährliche Stoffe in Materialien und Produkten. Auch die Umsetzung von Design-for-Recycling Ansätzen ist nach Einschätzung aller Teilnehmenden weiter zu stärken.
- Die obenstehende Systematik von Interventionsmechanismen und Ansätzen für den Informationstransfer ist sehr hilfreich, um die Diskussion über (Verbesserungen der) Informationsflüsse zu unterstützen.

- Zur Verbesserung der Informationsflüsse ist ein kontinuierlicher Dialog über den konkreten Bedarf an Informationen zwischen den Akteuren innerhalb der Abfallbehandlungsketten sowie zwischen dem Abfallsektor und der primären Lieferketten notwendig.
- Aktivitäten zur Kennzeichnung von Geräten, die besonderes problematische Inhaltsstoffe enthalten (wie z.B. brennbare Lithium-Ionen-Akkus oder aber staubende Vakuum-Isolationspanele), sind sinnvoll, um eine getrennte Behandlung zu ermöglichen.
- Kennzeichnungen von Produkten bzgl. der Schadstoffgehalte haben dann eine gute Chance praktisch umgesetzt zu werden, wenn sie bei üblichen Bandgeschwindigkeiten von großen Sortieranlagen mit vertretbarem Aufwand ausgelesen werden können.
- Es gibt keine Einheitslösung für die Informationsübermittlung und für jede Sortiertechnik und jeden Materialstrom können unterschiedliche Instrumente der Informationsübermittlung zielführend sein.
- Derzeit fehlen ökonomisch selbsttragende Lösungen für die weitere Optimierung der stofflichen Rezyklat-Qualitäten. Trenn- und Sortieraufwand sind zu hoch im Vergleich zu erzielbaren Preisen für die erreichbaren Sekundär-Materialqualitäten.
- Klar definierte „Ziel-Qualitäten“ für Sekundärmaterialien würden die Ausrichtung der abfallwirtschaftlichen Sortierprozesse erleichtern und den Absatz der Recyclingmaterialien fördern.
- Es gab keine einvernehmliche Meinung dazu, ob das gezielte Verschneiden von unterschiedlichen Recyclingmaterialien zum Erreichen solcher Qualitätsziele sinnvoll ist.
- Es wurde diskutiert, dass Primär- und Sekundärmaterialien dann als „gleichartig“ angesehen werden sollten, wenn das Risikopotenzial für ein definiertes Verwendungsmuster vergleichbar ist. Es könne nicht darum gehen, die stoffliche Zusammensetzung von Primärrohstoffen 1:1 zu reproduzieren.
- Das Konzept der nicht festgelegten und damit (fast beliebig) breiten Verwendungsmuster für Rezyklate wird dagegen als nicht zukunftsfähig angesehen.

Ansätze zur Stärkung der Abfallhierarchie bei Abfällen mit gefährlichen Inhaltsstoffen (=> FachDialog 3)

Das Ziel des 3. FachDialogs ist es, die derzeitige rechtliche Ausgangslage und die praktischen Herausforderungen der Umsetzung der Abfallhierarchie zu diskutieren, den Austausch zwischen Vertreter*innen von Behörden und der Praxis zu ermöglichen und gemeinsam Lösungsansätze in der Form von Entscheidungskriterien für die Umsetzung der Abfallhierarchie zu entwickeln.

Die politischen Vorgaben für das nachhaltige und kreislauffähige Wirtschaften bauen auf den folgenden Prinzipien auf:

9. Das Vermeiden/die Verringerung der Verwendung von bedenklichen Stoffen und von Abfällen mit gefährlichen Inhaltsstoffen sowie der Abfallmenge insgesamt;
10. Eine Abfallbehandlung, die möglichst große Mengen an Produkten einer Vorbereitung zur Wiederverwendung zuführt, die (aus stofflicher Sicht) sicher sind und die den gesetzlichen Anforderungen entsprechen;
11. Ein Recycling, das möglichst große Materialströme in Sekundärmaterialien überführt. Dabei ist eine Kreislaufführung bedenklicher Stoffe entweder auszuschließen oder sicherzustellen,

dass belastete Sekundärmaterialien nur in gut kontrollierten Anwendungen eingesetzt werden;

12. Das Ausschleusen von Stoffen mit (besonders) gefährlichen Eigenschaften aus den Materialkreisläufen.

Um die Ziele des EU Green Deal umsetzen zu können, brauchen die Akteure im Abfallsektor Orientierung darüber, wie sie mit Blick auf die Gehalte an bedenklichen Stoffen in den Abfallströmen die gesetzlich festgelegte Abfallhierarchie in der Praxis der Abfallbehandlung umsetzen können. Vor diesem Hintergrund wurde im dritten FachDialog das Thema „Stärkung der Abfallhierarchie: Entscheidungshilfen für die Auswahl von Behandlungswegen" in den Fokus genommen.

Bestehende gesetzliche Vorgaben für die (Auswahl der) Behandlungswege von Abfällen

Gemäß KrWG sind bei der Bewirtschaftung von Abfällen a) Umwelt und Gesundheit zu schützen und es soll b) die Effizienz der Ressourcennutzung gesteigert werden. Wie diese beiden Ziele gemessen und ggf. gegeneinander abgewogen werden, ist nicht abschließend definiert.

Im Abfallrecht bilden die möglichen Maßnahmen der Abfallbehandlung eine Hierarchie, die bei der Auswahl des Behandlungsweges zu berücksichtigen ist. Zudem sind die Auswirkungen der Abfallbewirtschaftung auf Mensch und Umwelt über den gesamten Lebenszyklus des Abfalls, also ggf. auch eine zweite Nutzungsphase zu betrachten. Die Rangfolge der Behandlungsmöglichkeiten ist:

- Vermeidung[6],
- Vorbereitung zur Wiederverwendung,
- Recycling,
- Sonstige Verwertung, insbesondere energetische Verwertung und Verfüllung,
- Beseitigung.

Von dieser Reihenfolge kann abgewichen werden, wenn Schutzziele dadurch besser erreicht werden können, z. B kann es erforderlich sein ein Abfall zu beseitigen, wenn er bedenkliche Stoffe enthält, die im 2. Lebenszyklus nicht sicher beherrschbare Risiken erzeugen. Zudem kann die technische und wirtschaftliche Zumutbarkeit einen Einfluss auf die Wahl des Behandlungsverfahrens haben. Das BMUV hat zur Auslegung der Rangfolge von Verwertungsmaßnahmen Leitlinien veröffentlicht.

In der EU und auf nationaler Ebene legen „Sammelquoten" fest, welcher Anteil der neu in Verkehr gebrachten Produkte nach Erreichen des Abfallstatus getrennt zu sammeln und zu erfassen ist. Recyclingquoten definieren den Prozentsatz der anfallenden bzw. erfassten Abfälle dieser Produkte, die einem Recycling-Verfahren zuzuführen sind. Die Umsetzung der Quoten wird in Deutschland mittels der Produktverantwortung erwirkt. Die Quoten stellen jedoch weder qualitative Anforderungen an die stoffliche Zusammensetzung der Abfälle bzw. erzeugten Sekundärmaterialien, noch legen sie fest, wie die Quoten erreicht werden sollen.

[6] Für die Diskussion war die Vermeidung von Abfällen nicht relevant, da der FachDialog auf Aspekte der Abfallbehandlung fokussiert war.

Weitere, die Auswahl der Verfahren zur Abfallbehandlung beeinflussende Faktoren, sind die Gefährlichkeit eines Abfalls (Abfallschlüssel mit Sternchen), was z. B. erfordern kann, dass die behandelnde Anlage entsprechende Genehmigungen oder technische Voraussetzungen erfüllt.

Das Chemikalienrecht beeinflusst die Wahl der Abfallbehandlungsverfahren durch die Vorgaben für das Inverkehrbringen der Sekundärmaterialien (z. B. Registrierungspflicht), da das Recycling als Stoffherstellung gilt. Eine Ausnahme von der Registrierungspflicht ist möglich, wenn a) der zurückgewonnene Stoff mit einem bereits registrierten Stoff identisch ist und b) dem Unternehmen, welches die Wiedergewinnung durchführt, entsprechende Sicherheitsinformationen für die Verwendung des Stoffes vorliegen, z. B. in Form eines Sicherheitsdatenblatts. Insofern muss das recycelnde Unternehmen ausreichende Kenntnis über die wiedergewonnenen Stoffe (Identität) und entsprechende Informationen für eine Registrierung oder eine Ausnahme davon haben.

Des Weiteren kann das Recycling von Abfällen, die zulassungspflichtige SVHCs enthalten, dadurch eingeschränkt werden, dass für die Handhabung der erzeugten Sekundärmaterialien eine Zulassung für den Recyclingbetrieb (und auch dessen Kunden) vorliegen muss. Da Zulassungsanträge spezifisch für die jeweiligen Wertschöpfungsketten sind, sind die Aktivitäten der Recycling-Unternehmen und ihrer Kunden nicht durch andere Zulassungen abgedeckt. Zusätzlich können Zulassungsentscheidungen zur Überprüfung potenzieller Risiken am Ende der (primären) Stoffnutzung die Einhaltung bestimmter Bedingungen in der Abfallbehandlung erforderlich machen, z. B., dass aus einem Verfahren keine Emissionen in Gewässer entstehen.

Abfälle, die persistente organische Schadstoffe enthalten, unterliegen den Anforderungen der EU POP-Verordnung. Für Abfälle, deren POP-Gehalt definierte Grenzwerte erreicht oder überschreitet, gelten Vorgaben zur Behandlung dieser Abfälle, u.a. ein Vermischungsverbot und die Vorgabe zu unumkehrbarer Umwandlung oder Zerstörung des POP-Gehaltes.

Auch Beschränkungen unter REACH können die Auswahl des Behandlungsverfahrens für Abfälle beeinflussen, indem sie bestimmte Stoff-Verwendungen oder auch die Anwesenheit der Stoffe in Produkten verbieten und damit einen Einfluss auf ein mögliches In-Verkehr Bringen nach einer Vorbereitung zur Wiederverwendung oder die Vermarktung von Sekundärrohstoffen im Anschluss an ein Recycling haben (können).

Die Auswahlmöglichkeiten bei den Behandlungswegen können rein faktisch auch dadurch begrenzt werden, dass nachfolgend beim wieder Inverkehrbringen von Rezyklaten entsprechende chemikalienrechtliche Anforderungen einzuhalten sind und die notwendigen Informationen fehlen. Nach einer Vorbereitung zur Wiederverwendung ist es z.B. notwendig die Informationspflicht für SVHC (gemäß Art. 33 von REACH) für das entsprechende Erzeugnis einzuhalten bzw. einhalten zu können. Darüber hinaus besteht bei chemischen Produkten (Stoffen & Gemischen), die als Rezyklate vermarktet werden sollen, die Anforderung eine chemikalienrechtliche Einstufung und Kennzeichnung durchzuführen.

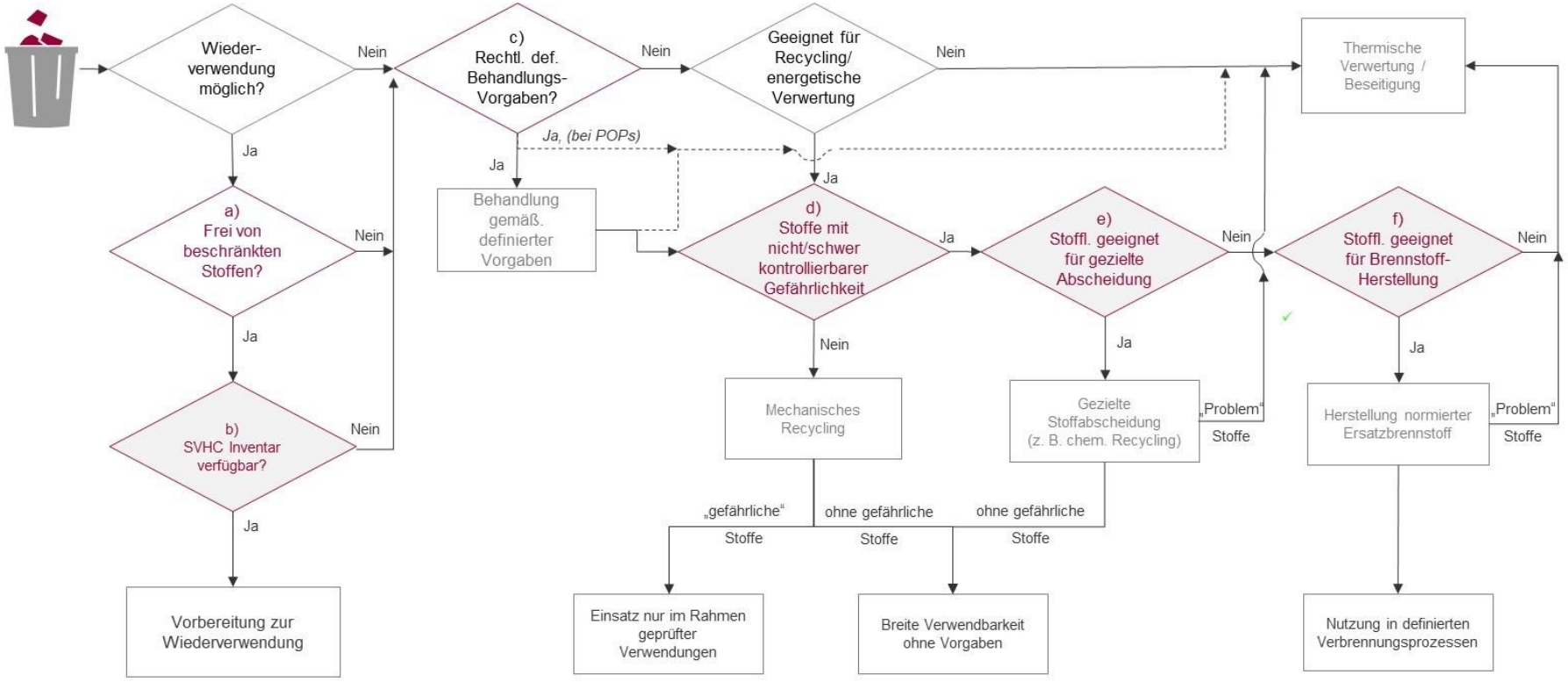
Innerhalb der durch gesetzliche Regelungen gesteckten Grenzen kann die Abfallhierarchie unterschiedlich umgesetzt werden. Die Identifizierung einer „optimalen Abfallbehandlung“ sollte die Ziele „Ressourcenschonung“ und „Schutz von Gesundheit und Umwelt vor toxischen und ökotoxischen Risiken“ ausbalancieren. Hierbei sind lt. KrWG die zu erwartenden Emissionen, das Maß der Schonung der natürlichen Ressourcen, die einzusetzende oder zu gewinnende Energie sowie die Anreicherung von Schadstoffen in Materialkreisläufen gegeneinander abzuwägen.

Figure 8 zeigt die grundlegende Struktur eines Entscheidungswegs zur Identifizierung der geeigneten Behandlungs-, Recycling und Verwertungswege, welche die Abfallhierarchie beachtet

und dabei dem Inventar an „gefährlichen Inhaltsstoffen“ Rechnung trägt. Die zentralen Fragen an den jeweiligen stoffbezogenen Entscheidungspunkten werden nachfolgend erläutert. Dieser Entscheidungsweg behandelt ausdrücklich die konzeptionelle Abfolge von schadstoffbezogenen Fragen. In den abfallwirtschaftlichen Prozessen sind die Behandlungswege vor allem aufgrund von technisch-ökonomischen Erwägungen in vielen Fällen bereits weitgehend vorab festgelegt.

Daher werden in der Praxis einzelne oder alle dieser konzeptionellen Prüfschritte „übersprungen“.

Abbildung 17: Entscheidungsbaum für die Wahl der geeigneten Entsorgungswege für Abfälle, die gefährliche Stoffe enthalten



Quelle: eigene Darstellung, Ökopol

Nachstehend die Erläuterungen zu den Fragen an den Entscheidungspunkten:

a) Für Produkte, die für eine Vorbereitung zur Wiederverwendung geeignet sind, ist zu prüfen, ob sie Stoffe enthalten, die aufgrund einer „neuen“ Beschränkung nicht (mehr) enthalten sein dürfen.

b) Vor einer möglichen Vorbereitung zur Wiederverwendung muss überprüft werden, ob ein vollständiges SVHC-Inventar des Produktes verfügbar ist, damit der Informationsverpflichtung nach Artikel 3 REACH nachgekommen werden kann.

c) Ggf. sind für den Abfallstrom rechtlich vorgeschriebene, spezifische (Vor-)Behandlungsverfahren umzusetzen (z. B. gemäß Altautoverordnung). Zudem ist zu prüfen, ob eine Abfallfraktion Stoffe enthält, die dem Recycling nicht zugeführt werden dürfen und entsprechend separiert bzw. beseitigt werden müssen.

d) Bei Abfallfraktionen, die grundsätzlich für ein Recycling und/oder eine energetische Verwertung geeignet sind, ist zu prüfen, ob sie sich für „einfache“, meist rein mechanische Recyclingverfahren ohne gezielte Stoffabscheidung eignen. Dies wäre der Fall, wenn a) keine gefährlichen Stoffe enthalten sind und daher auch eine breite Verwendung der Sekundärmaterialien möglich ist oder b) die enthaltenen gefährlichen Stoffe keine SVHCs sind und die Nutzung der Sekundärmaterialien auf Verwendungen begrenzt werden kann, in denen (aufgrund der dort bestehenden Expositionsbedingungen) keine Risiken entstehen können.
Sind im Abfallstrom SVHC-Stoffe enthalten und/oder ist dies nicht bekannt und kann die Verwendung der Sekundärmaterialien nicht kontrolliert werden, sollte kein mechanisches Recycling stattfinden.

e) Ist ein „einfaches Recycling“ nicht sachgerecht, kann im nächsten Schritt beurteilt werden, ob ein Recyclingverfahren mit gezielter Abscheidung/Zerstörung der problematischen Stoffe möglich ist.

f) Als weitere Option kann geprüft werden, ob sich die Abfallfraktion mit Blick (auch) auf das Schadstoff-Inventar zur Herstellung von normierten Ersatzbrennstoffen und damit für eine thermische Verwertung nutzen lässt.

Überlegungen zum Einsatz von Rezyklaten, die gefährliche Stoffe enthalten

Grundsätzlich sind für den Einsatz von Rezyklaten 3 Fälle denkbar:

- Einsatz in den gleichen Produkten, aus denen sie gewonnen wurden (Closed Loop);
  Im Abfall enthaltene (gefährliche) Stoffe können ggf. ihre Funktion auch im Recyclingprodukt erfüllen (z. B. Kunststoffadditive) und der Neu-Einsatz dieser Stoffe kann vermieden werden. Im Closed Loop kann es auch akzeptabel sein, SVHCs im Kreislauf zu führen, soweit dies nicht durch eine Stoffbeschränkung verboten ist sowie Risiken in dieser Verwendung ausgeschlossen sind.

- Einsatz in Produkten, mit geringem Expositionspotenzial für Mensch und Umwelt;
  Sind gefährliche Stoffe im Sekundärmaterial vorhanden, ist eine Verwendung nur in solchen Produkten akzeptabel, aus denen sie kaum freigesetzt werden und bei denen kein direkter Kontakt mit der Haut möglich ist, d. h. die Exposition von Umwelt und/oder Menschen so niedrig ist, dass keine schädlichen Effekte zu erwarten sind.

- Einsatz ohne Einschränkung der Verwendung;
  Sekundärmaterialien, die keine oder nur „wenig gefährliche“ Stoffe enthalten (die zudem kaum freigesetzt werden), können frei verwendet werden.

Ist unbekannt, ob und welche Stoffe in einem Sekundärmaterial enthalten sind oder sein könnten, muss zwischen den Zielen der Steigerung des Recyclings und der Herstellung sicherer Materialien entschieden werden. In der Regel wird der Sicherheit Vorrang eingeräumt, d. h. Materialien, die aus stofflicher Sicht geeignet wären, werden aus Vorsorgeerwägungen nicht rezykliert. Um hier die Recyclingpotenziale weiter auszuschöpfen, müssten zusätzliche Bewertungsinstrumente erarbeitet werden, die sich an der REACH Stoffsicherheitsbewertung orientieren und für die Akteure der Abfallwirtschaft praktikabel sind. Langfristig sollte zudem das Ziel sein, Stoffe mit bestimmten Eigenschaften gar nicht einzusetzen (Stichwort nachhaltige Chemie bzw. „Safe by Design“ Ansatz) oder bereits beim Design von Erzeugnissen die Entsorgung stärker zu berücksichtigen (erweiterte Herstellerverantwortung).

Diskussionen im Dialog-Workshop 3

Nachfolgend werden einige zentrale Punkte aus den Diskussionen des FachDialogs 3 wiedergegeben:

- Alle Ebenen der Abfallhierarchie, einschließlich der Beseitigung sind für eine funktionierende Kreislaufwirtschaft wichtig.
- Bei der Entscheidung über das geeignete Behandlungsverfahren sind die Ziele der Ressourceneffizienz und der Schadstofffreiheit gleichrangig zu berücksichtigen. In der Diskussion wurde deutlich, dass einerseits gewünscht wird die (komplexen) Auswirkungen einer Behandlung zu bewerten und zur Entscheidungsgrundlage zu machen. Andererseits sollen die Instrumente zur Entscheidungsunterstützung jedoch einfach und mit wenig Aufwand nutzbar sein. Für diesen Widerspruch konnte keine Lösung gefunden werden.
- Ein Recycling gefährlicher Inhaltsstoffe kann unter „Closed-Loop“ sinnvoll sein. Voraussetzung dafür ist, dass
  - die gefährlichen Stoffe in Bezug auf Konzentration und Matrixbindung vergleichbar wie im Primärprodukt enthalten sind,
  - Die Nutzung der Sekundärprodukte in Bezug auf Expositionsrisiken für Mensch und Umwelt denen der ursprünglichen Produkte vergleichbar sind, und
  - diese Verwendung der Stoffe anhand einer Risikobewertung als „sicher“ identifiziert wurde.
- In der Praxis gibt es allerdings Schwierigkeiten sowohl bei der Prüfung der Verwendungsbedingungen als auch bei der Steuerung des Einsatzes von Sekundärmaterialien.
- Derzeit laufen parallel vergleichsweise viele Prozesse zur Stärkung der nachhaltigen und kreislauforientierten Wirtschaft in Bezug auf die Anpassung des gesetzlichen Rahmens im Chemikalien-, Produkt- und Abfallrecht. Es besteht die Gefahr, dass aufgrund fehlender Querabstimmungen und der begrenzten Ressourcen der jeweiligen Akteure, Inkonsistenzen entstehen und so aus übergreifender Perspektive suboptimale Rahmensetzungen beschlossen werden.

- Eine funktionierende Kreislaufwirtschaft fängt bereits bei einem Produktdesign an, welches Chemikalien verwendet, die das Recycling nicht behindern. Auch dies erfordert eine (verstärkte) Kooperation der Akteure.

Aus den FachDialogen abgeleitete Handlungsansätzen zur Stärkung des Risikomanagements gefährlicher Stoffe im Zusammenspiel von Chemikalien- und Abfallrecht

Während der Projektarbeiten wurde deutlich, dass in Bezug auf die Schnittstellen zwischen dem Chemikalienrecht und dem Abfallrecht faktisch zwei unterschiedliche Bereiche zu diskutieren sind, in denen sich Handlungsbedarf erkennen lässt.

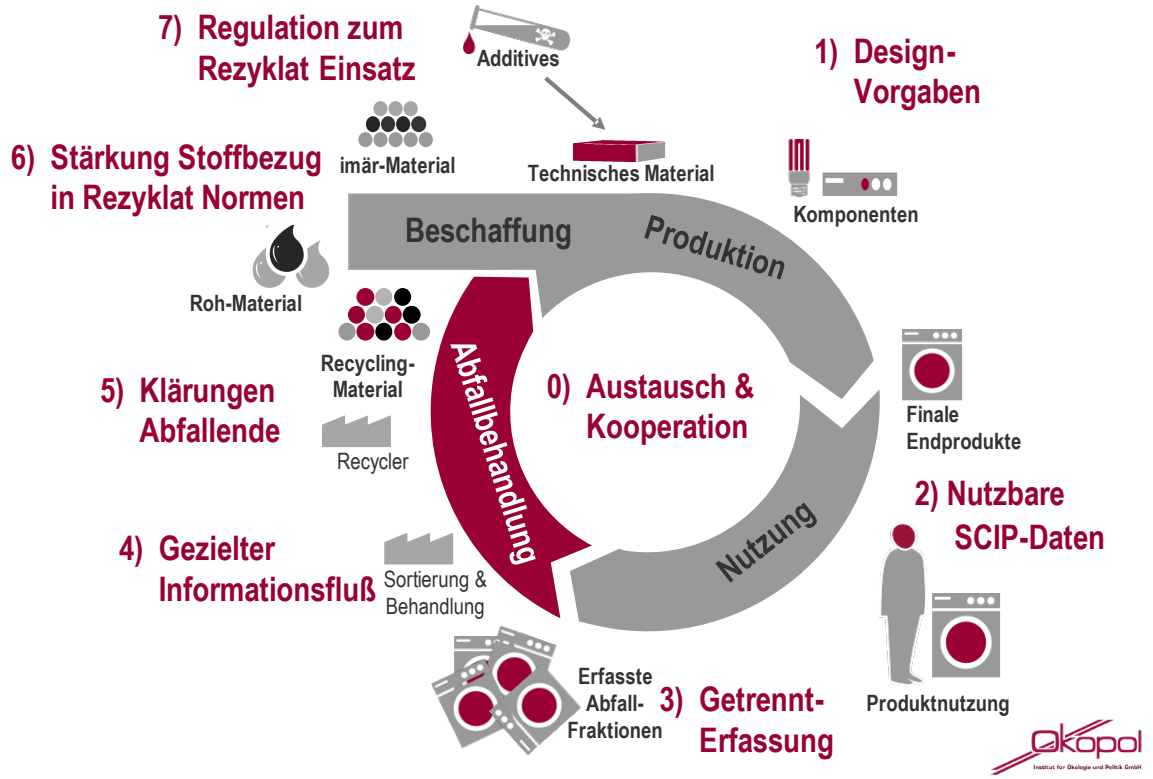
Dies sind auf der einen Seite (A) der Umgang mit und die Kontrolle von stofflichen Risiken, die bei einer Kreislaufführung von (Abfall-)Materialströmen besonders in Bezug auf die erneute Nutzung in der 2. Nutzungsphase entstehen (können). Auf der anderen Seite (B) handelt es sich um die Optimierung des Managements stoffbezogener Risiken innerhalb der Abfallphase.

(A) Die Verbesserungen der Kontrolle stofflicher Risiken bei der Kreislaufführung und in der 2. Nutzungsphase

Die abfallwirtschaftlichen Prozesse werden in der Kreislaufwirtschaft von den Marktakteuren zunehmend als sekundäre Lieferketten verstanden, und nicht mehr wie früher vorrangig als nachlaufende Lösungen zur schadlosen und gemeinwohlverträglichen Entsorgung. Damit erhalten die Zielqualitäten der Behandlungs- und Recyclingprozesse und die entsprechenden Qualitätssicherungs- und Kommunikationsroutinen einen neuen Stellenwert. Aber auch die Gestaltung der primären Produkte – die faktisch die „Rohstoffquelle“ der sekundären Lieferkette bilden sowie weitere Aspekte, wie z. B. die Abfallerfassung, erhalten bei diesem Perspektivenwechsel einen neuen Stellenwert.

Vor diesem Hintergrund haben die Autor*innen basierend auf den Recherchen und den Diskussionen im Gesamtvorhaben, die in der folgenden Grafik (Abb. 9) dargestellten 8 Ansatzstellen für Maßnahmen zur Stärkung der Kreislaufführung identifiziert:

Abbildung 18: Ansatzstellen zur Stärkung der Kreislaufführung bei gefährlichen Inhaltsstoffen



Quelle: eigene Darstellung, Ökopol

Wichtig zum Verständnis dieser Maßnahmenvorschläge ist, dass es

g) zur Wirksamkeit immer das gesamte Paket an Veränderungen in allen verschiedenen Bereichen braucht,

h) die Ansätze – der Logik einer (sekundären) Lieferkette entsprechend – „vom Ende her“ gedacht und verstanden werden müssen, also von der 2. Nutzung der Sekundärmaterialien her.

Das angestrebte Zusammenspiel der vorgeschlagenen Maßnahmen lässt sich in knapper Form wie folgt beschreiben:

Zu 7 „Regulation zum Rezyklateinsatz“:
Ein System aus klaren Verwendungsbeschränkungen und Ausnahmeregelungen stellt sicher, dass Sekundärmaterialien abhängig von ihren Gehalten an gefährlichen Stoffen nur in Produktverwendungen und späteren Nutzungen gelangen, für die sie als „sicher“ beurteilt wurden.

Zu 6 „Stärkung des Stoffbezug in Rezyklat Normen“:
Normungen und andere Standards für Sekundärmaterialien enthalten klare Definitionen von Schadstoffklassen, die mit Anforderungen an die vorlaufende Qualitätssicherung und mit „sicheren“ sekundären Verwendungsmöglichkeiten verbunden sind. Dies schafft Vertrauen bei den Rezyklat-Verwendern, unterstützt so die Entstehung einer breiten Marktnachfrage nach standardisierten Sekundärmaterialien und gibt den Akteuren der Abfallbehandlungs- und Recycling-Ketten damit klare Zielvorgaben.

Zu 5 „Klärungen Abfallende“:
Einheitlich festgelegte und vollzogene Festlegungen zum Abfallende fordern die Durchführung von (standardisierten) Qualitätssicherungsschritten und stellen sicher, dass nur Stoffe und Gemische wieder den Produktstatus erlangen, zu denen basierend auf der Prüfung von Einstufung und Kennzeichnung entsprechende Stoff- und Sicherheitsinformationen für die Verwender im 2. Lebensweg verfügbar gemacht werden.

Zu 4 „Gezielter Informationsfluss“:
Die Akteure der Abfallwirtschaft werden bei einer, den Gehalt an gefährlichen Stoffen berücksichtigenden Sortierung- und Behandlung der Abfallfraktionen unterstützt, indem sie zum einen mit den Abfall- „Objekten“ direkt auswertbare „klassifizierende“ Informationen zu gefährlichen Inhaltsstoffen erhalten. Dies ergänzt gezielt die Informationen der schadstoffbezogenen Planung und Auslegung der Behandlungsprozesse auf Basis verfügbarer Detailinformationen zum Schadstoffinventar verschiedener Abfall-„Objekte“ und Abfall-Fraktionen (vergl. Ansatz 2).

Zu 3“Getrennterfassung“:
Vorgaben der getrennten Erfassung von Erzeugnis-Abfällen die auf ihre Anschlussfähigkeit an die (auch) gefahrstoffbezogenen Sortierbestrebungen der Abfallbehandlung überprüft wurden, unterstützen die Effizienz dieser Sortierbestrebungen sowie die Effektivität der späteren Qualitätssicherung der Recycling-Materialien.

Zu 2 „Nutzbare SCIP-Daten“:
Datenbanken (wie z.B. eine entsprechend modifizierte/erweitere SCIP-Datenbank) enthalten quantifizierte und periodisch aktualisierte Informationen zum Gehalt an gefährlichen Stoffen (insbesondere zu SVHC sowie zu weiteren regulierten Stoffen), für die auf dem Markt und in der Nutzungsphase befindlichen Erzeugnisse. Auswertungsmöglichkeiten „quer“ über Produktgruppen und/oder Abfall-Sammelgruppen geben den Akteuren der Abfallwirtschaft eine valide Basis für die gefahrstoffbezogene Planung und Auslegung von Sortier- und Behandlungsprozessen.

Zu 1 „Design-Vorgaben“:
Freiwillige und/oder allgemein verbindliche Vorgaben an das Öko-Design von technischen Materialien und Erzeugnissen führen zu einer Überprüfung und damit auch Begrenzung der für die Funktionalisierung technischer Materialien eingesetzten Stoffe mit gefährlichen Eigenschaften. Vereinheitlichungen des funktional benötigten Inventars an gefährlichen Stoffen erfolgen mit Blick auf die Verwendung in Produktgruppen mit einer späteren gemeinsamen Abfallbehandlung. Die resultierende Reduzierung und Vereinheitlichung des „erwartbaren“ Gefahrstoffinventars ist ein zentraler Aspekt mit Blick auf die Effizienz und Effektivität aller im Lebenszyklus nachfolgenden Schritte zur Steigerung der Quantität der Kreislaufführung „sicherer“ Materialströme.

Zum Erreichen dieses Gesamtbildes sind in den verschiedenen Ansatzpunkten jeweils entsprechende, z.T. substantielle Veränderungen notwendig. Diese können durch entsprechende Maßnahmen des Verordnungsgebers oder anderer staatlicher Stellen unterstützt werden (entsprechende Möglichkeiten werden im Abschnitt 5.2.1 des Gesamtberichtes skizziert). Parallel dazu ist es aber unverzichtbar, dass das verbindliche und kooperative Zusammenwirken aller an der Kreislaufführung von Materialien beteiligter Marktakteure gestärkt wird. Aus diesem Grund gibt es den übergreifenden Vorschlag zum Ansatzpunkt 0.

Zu 0 „Austausch & Kooperation“:
Die Marktakteure im gesamten (mehrfachen rekursiven) Lebenszyklus eines technischen

Materials bilden Dialog-Foren und Arbeitsgremien, die dem systematischen Informationsaustausch und der sachgerechten Abstimmung der Ausgestaltung von Maßnahmen dienen. Diese Maßnahmen unterstützen die übergreifende Zielstellung, die Etablierung „sicherer" und gleichzeitig quantitativ relevanter und damit ressourcenschonender Kreislaufführungen des gemeinsam „bewirtschafteten" Materialstroms. Dabei ist es wichtig, dass alle beteiligten Marktakteure ein klares Bekenntnis zu dieser Zielstellung abgeben. Das beinhaltet auch die Bereitschaft substanzielle Veränderungen an bestehenden Material- und Produktdesigns, bestehenden Geschäftsmodellen und Technikprozessen zu prüfen und ggf. zu ergreifen.

(B) Optimiertes Management stofflicher Risiken innerhalb der Abfallwirtschaft

Eng verknüpft mit den Bestrebungen zur Stärkung der Kreislaufführung von Materialien, die gefährliche Stoffe enthalten (können), aber dennoch gut abgrenzbar, ist die Diskussion zur weiteren Optimierung des Managements stofflicher Risiken innerhalb der Abfallwirtschaft. Zentrale Frage ist hier, wie der dynamisch anwachsende Bestand an Fakten und Erkenntnissen aus den Prozessen der Stoff- und den Risikobewertungen unter REACH auch für die Akteure der Abfallwirtschaft zugänglich und wirksam werden kann.

Zur Behebung tendenzieller Unausgewogenheit beim Management stofflicher Risiken zwischen dem Produkt- und dem Abfallbereich haben die Autor*innen die folgenden 4 Ansatzpunkte für mögliche Verbesserungsmaßnahmen identifiziert:

1. **Ermittlung „sicherer Verwendungsbedingungen" in typischen Abfallbehandlungsprozessen im Rahmen der Registrierung von Stoffen unter REACH**
   Die Registranten von Stoffen könnten dazu verpflichtet werden, im Rahmen der Stoffsicherheitsbeurteilung, jeweils auch die Risiken abfalltypischer „Verwendungen" (Prozesse) wie:

   - staubförmige Freisetzung beim mechanischen Brechen der Materialmatrix (z.B. beim Shreddern von Materialien in denen der Stoff eingebracht wird),
   - Freisetzung nicht zerstörter Stoffe aus Verbrennungsprozesse in die Umwelt sowie
   - Eintrag in Gewässer, bzw. Luft nach Migration und Freisetzung aus einer Matrix

   zu beurteilen und die entsprechenden Expositionsszenarien sowie ggf. abgeleitete Risikomanagementmaßnahmen in geeigneter Form für die Akteure der Abfallwirtschaft verfügbar zu machen. Dies würde die Akteure der Abfallwirtschaft substantiell bei der Prüfung und ggf. Anpassung ihrer jeweiligen standort- und prozessbezogenen Risikoanalysen unterstützen.
2. **Implementierung abfallstrombezogener Abfragemöglichkeiten in die SCIP-Datenbank**
   Für die Beurteilung des bei verschiedenen Abfallfraktionen zu erwartenden Gefahrstoff-Inventars und zur Ableitung entsprechender Planungsvorgaben an angepasste Sortier- und Behandlungsprozesse benötigen die Akteure der Abfallwirtschaft sowohl zusätzliche Informationen in der Datenbank als auch angepasste Möglichkeiten zur Abfrage der Daten. Die notwendigen zusätzlichen Informationen sind insbesondere:

   - Die konkreten Mengenanteile der gefährlichen Stoffe in den jeweiligen technischen Materialien (in den Erzeugnissen),
   - Entsprechende Angaben zu weiteren (regulierten) gefährlichen Stoffen über die SVHCs hinaus,

- Die typischen Abfallschlüssel, unter denen eine spätere Entsorgung der Erzeugnisse zu erwarten ist.

Um dem z.T. relevanten zeitlichen Versatz zwischen der Vermarktung der Erzeugnisse und ihrem Eintritt in die Abfallphase Rechnung zu tragen, sind die Datensätze in der SCIP-Datenbank darüber hinaus periodisch (z.B. in Bezug auf zwischenzeitlich „neu" identifizierte SVHCs oder regulierte Stoffe) zu aktualisieren.
Die Abfragemöglichkeiten betreffen:

- Abfrage quer über Gruppen gleichartiger Erzeugnisse („Produktgruppen-Abfragen"),
- Abfragen nach möglichen Abfallfraktionen (über die Abfallschlüssel der zu erwartenden Entsorgungswege).

3. **Überprüfung der Spiegeleinträge für Abfälle, die aus der Nutzung von Erzeugnissen resultieren, im Abfallverzeichnis**
   Aufgrund der extrem hohen stofflichen Heterogenität der meisten Abfälle, die vor dem Beginn ihrer Abfalleigenschaft als Erzeugnisse genutzt wurden, können aus der Einstufung der entsprechenden Abfallfraktionen als gefährlich oder als nicht-gefährlich faktisch keine hilfreichen Informationen für ein sachgerechtes Risikomanagement bei der weiteren Behandlung dieser Abfallfraktionen gezogen werden. Vor diesem Hintergrund erscheint es sinnvoll, das Vorliegen und das Nicht-Vorliegen von Spiegeleinträgen im Bereich der Abfälle systematisch daraufhin zu überprüfen, ob Maßnahmen der Stoffstromsteuerung dieses Instrument erforderlich machen oder wo zur Entlastung der beteiligten Akteure auf derartige Spiegeleinträge verzichtet werden kann.

   Der Informationsfluss zu gefährlichen Inhaltsstoffen und die Durchführung entsprechender Risikobeurteilungen für die verschiedensten Prozesse der Abfallbehandlung müssen für alle Abfälle und unabhängig von der Abfalleinstufung sichergestellt werden. Dazu dienen u.a. die hier skizzierten Handlungsansätze.

4. **Umsetzung inputspezifischer Risikomanagementmaßnahmen**
   Die Betreiber von Sortier-, Behandlungs- und Recyclinganlagen für Abfälle nutzen systematisch die Informationen zu spezifischen, durch die gefährlichen Inhaltsstoffe bedingten Risiken (vergl. die vorstehenden Ansätze a und b) der bei ihnen gehandhabten Abfallströme für ihre Risikoanalysen (Gefährdungsbeurteilungen, Emissionsbetrachtungen) und überprüfen auf dieser Basis regelmäßig die bei ihnen etablierten Risikomanagementmaßnahmen.

1 About the project

1.1 Subject matter and objectives

Many important functions of the products on the market today are based on the properties of chemical substances that have been deliberately added to them. Some of these substances have hazardous properties that can pose risks to human health and the environment under unfavourable conditions.

Against this background, a series of protective regulations have been established in product and chemicals legislation as well as in waste legislation over the last decades, which are implemented both in the responsibility of the market actors and through legal regulations. Due to the rapidly growing scientific knowledge about the hazardous properties of chemicals and the potential environmental and health risks they pose, these established protective regulations are also subject to a dynamic adaptation process.

Due to different legal systems and the complexity of the relevant adaptation processes, there are currently some friction losses at the interfaces between the regulatory areas of waste and chemicals legislation due to apparently contradictory requirements and criteria. This can lead to desirable market developments being impeded or the desired level of protection not being fully achieved, or to legal uncertainties for the actors involved.

In order to better understand the challenges for the market actors involved and the enforcement of the existing regulations by the state authorities, the German Environment Agency (UBA) conducted this three-part dialogue project as part of the departmental research plan. In addition to a better understanding of the challenges, the project also aimed to discuss and document concrete approaches for appropriate solutions with all stakeholders.

The three expert dialogues dealt with the following main topics:

- Dialogue 1: Interlinking chemicals and waste legislation - current status, complementary needs, challenges and possible solutions
- Dialogue 2: Information flow on substances of concern at the interfaces of chemicals and waste legislation - requirements and needs as well as challenges and approaches to solutions
- Dialogue 3: Strengthening the waste hierarchy - Decision support for the selection of treatment routes

1.2 Procedure

In order to prepare the content of the dialogues and to support the necessary coordination between the UBA, the Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) and the contractor, Ökopol prepared so-called "situation analyses" for all three dialogues.

Based on the questions identified in these working documents, Ökopol developed the concepts and programmes for the individual dialogue events. These were the subject of further coordination between UBA/BMUV and Ökopol and subsequently formed the basis for the selection of participants, the formulation of the invitation and the recruitment of expert speakers.

Due to the pandemic, the dialogues were organised as online video conferences in a circle of 15 to 30 people. When designing the programme, care was taken to ensure that there was sufficient

time for discussion of the content. The contents of the presentations and the results of the discussions between the participants were recorded. All minutes were given to the participants for review and revised according to the comments.

The results achieved in this work process form the basis for this final report of the overall project.

1.3 Overarching, technical basis

1.3.1 Demarcation between the regulatory areas

There is a clear separation between the two legal areas of chemicals legislation and waste legislation. In principle, only the regulations of one of the two areas of legislation apply. The regulations of waste legislation are decisive for the transition from one area of legislation to the other: According to § 3 (1) of the Circular Economy Act (KrWG), waste is every *"[...] substance or object which its owner discards, intends to discard or must discard"*. This results in further subjective or objective framework conditions according to § 3 (2 and 3) KrWG for situations in which disposal can or must be assumed. It is important to note here whether the previous owner of the substances or objects sends them for (waste) treatment or recovery, i.e. decides that they are to be handled as waste in future (§ 3 (1) KrWG). Alternatively, an intent to dispose can be assumed if the substances or objects are created in the course of an activity without being the aim of the activity[7] or if they lose their original purpose through use without acquiring a new one, i.e. they effectively become unusable (§ 3 (3) KrWG). If such substances or objects thus become waste, they are subject to waste legislation and at the same time exit the chemicals legislation and, if applicable, additionally the relevant product legislation.[8]

If, on the other hand, the waste property ends after a successful recovery process in accordance with the reasons specified in § 5 KrWG, the requirements of the chemicals legislations will automatically fully apply again (c.f. **Fehler! Verweisquelle konnte nicht gefunden werden.**). The core criteria for the end of waste status after a recovery procedure are:

- a new purpose for the resulting product,
- an existing market,
- compliance with applicable standards and legal regulations, and
- ensuring that the use of the (resulting) substance or object as a whole does not lead to harmful environmental or health effects.

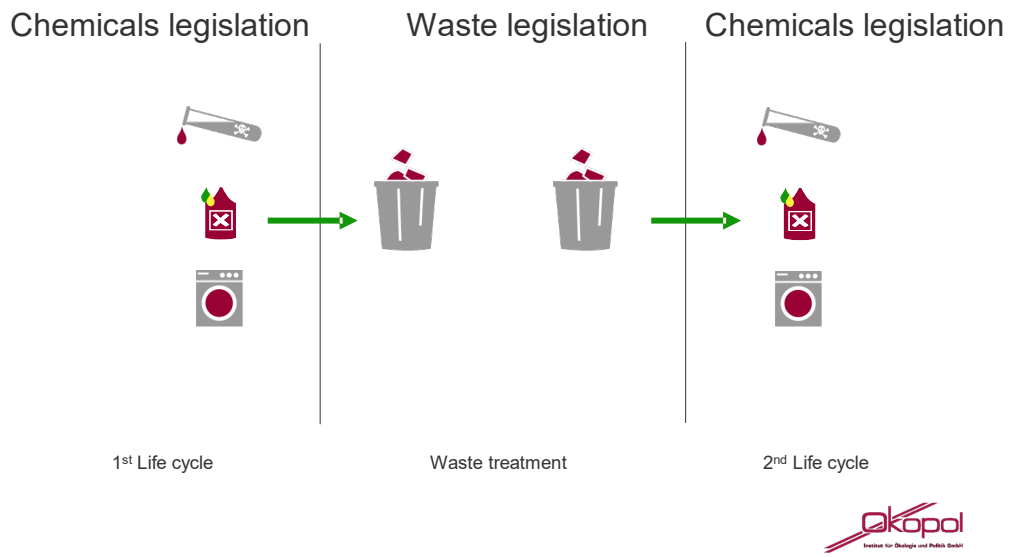
In the KrWG and other, subordinate waste stream-specific regulations, further specifications are made, especially with regard to the latter aspect of environmental and health protection, according to which regulations must be made regarding which wastes can leave the waste

[7] Here wastes are delineated from by-products in the sense of § 4 KrWG. By-products are also not the main goal of a process, but the intent to discard does not exist and therefore, these products are covered by chemicals legislation or other product legislation, respectively. Based on the existing provisions, an intent to discard can, however, be derived and defined, stating that it is not a by-product but a waste, which brings them into the scope of that legislation. §4 includes criteria indicating under which conditions the status of a by-product may apply (possible further use, no further treatment necessary, integral part of the process, no legal reasons that contradict this decision and no risks for health or the environment).

[8] Generally, chemicals legislation is applicable to all products, which are not explicitly exempted from the scope according to Art. REACH. In addition, in some product areas there are additional legal provisions (e.g. medical devices or toys).

status. In addition, harmonised criteria have been developed at European level for individual waste streams, such as, glass[9] and metal[10], which are used to determine the end of waste.

Figure 19: Separation of chemicals legislation and waste legislation



Source: own representation, Ökopol

There are key differences between chemicals legislation and waste legislation with regard to the subject matter of regulation. While chemicals legislation differentiates between different but clearly defined objects (substance, mixture, article), the uniform reference value in waste legislation is always the waste. Theoretically, a waste can consist of exactly one substance, a defined mixture or a clearly describable type of product. However, in practice it is usually a mixture whose concrete composition varies to a greater or lesser extent over time or depending on the place of collection. Any approach to properly limit potential substance-related risks to human health or the environment (risk management) must take these fundamental differences into account.

In the following sections, the central regulatory subjects of both areas of legislation are systematically presented.

1.3.2 Central subjects of regulation in the area of chemicals legislation

1.3.2.1 Products

The Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH[11]) and the Regulation on Classification, Labelling and Packaging of Substances and

[9] C.f. Regulation (EC) No. 1179/2012 of the Commission of 10. December 2012 with criteria for the definition of when certain types of glass cullet are according to Directive 2008/98/EC of the European Parliament and the Council are not to be considered waste anymore.

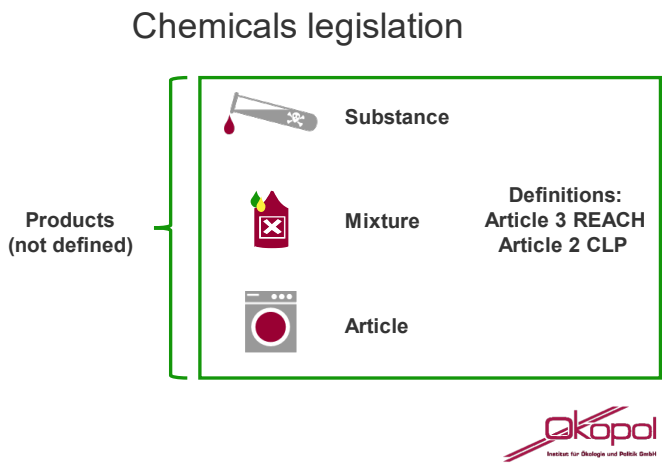
[10] C.f. Regulation (EC) No. 333/2011 of the Council of 31. March 2011 laying down criteria to define when certain types of scrap according to Directive 2008/98/EC of the European Parliament and the Council are not to be considered waste anymore. Regulation (EC) Nr. 715/2013 of the Commission of 25. July 2013 laying down criteria when certain types of copper scrap according to Directive 2008/98/EC of the European Parliament and the Council are not to be considered as waste anymore.

[11] Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC.

Mixtures (CLP[12]) form the core of chemicals legislation and apply to all "products" traded on the EU internal market. These regulations also define the terms substance, mixture and article.

The term "product", on the other hand, is not legally defined and is used in the context of this analysis (only) if the distinction into substance, mixture and/or article is not relevant (cf. Figure 20). For the legal requirements, the assignment to the three legally defined categories substance, mixture or article is decisive.

Figure 20: Subjects of regulation in chemicals legislation (types of products)



Source: Own representation, Ökopol

The European Chemicals Agency (ECHA) has published several guidance documents on the interpretation of the definitions[13]. The distinction between a substance and a mixture is particularly important because the registration requirements only apply to substances, not to mixtures. On the other hand, the basic obligations for classification and labelling as well as the dissemination of corresponding information are almost identical and thus remain almost unaffected by the distinction. However, the delimitation of substances or mixtures can be far more complex in individual cases and may also be the subject of controversial discussions.

The forms that a product can take according to REACH Article 3 or CLP Article 2 and the core requirements associated with them are briefly described below.

1.3.2.2 Substances

A substance is the central reference point of REACH and CLP. A substance can be both a highly purified single substance and a mixture of a few or many different compounds (substances of unknown and variable composition, complex reaction products or biological materials (UVCB)). The decisive factor for the substance definition in such cases is the manufacturing process by which the substance is obtained.

"[...] 'substance' means a chemical element and its compounds in the natural state or obtained by any manufacturing process, including any additive necessary to preserve its stability and impurity

[12] Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006.

[13] For the naming of substances, there is the guideline "Guidance for the Identification of Substances" https://echa.europa.eu/documents/10162/23036412/substance_id_de.pdf/eb1721f9-74ec-4f8c-8aa3-1490fd510685. The "Guidance on articles" addresses, among other things, delimitation aspects between substances/mixtures and articles. https://echa.europa.eu/documents/10162/23036412/articles_de.pdf/cbc54016-5d57-3737-60a1-f562738e2094

deriving from the process used, but excluding any solvents which may be separated without affecting its stability of the substance or changing its composition;". [...] REACH Article 3(1) and CLP Article 2(7).

Examples of substances that may consist of different constituents are, e.g. extracts from plants that contain many different types of substances, but which are obtained together in an extraction process. Even if the proportions of the individual substances vary in different production batches, they can legally fulfil the definition of a substance in their entirety. Another example of the mixing of compounds and regarding them as one substance are various distillates from the splitting of crude oil.

Substances manufactured in or imported into the European Union (EU) in quantities of more than 1 tonne per year and manufacturer/importer must be registered under REACH. This means in particular that manufacturers and importers must provide information on the substance properties and safe use in a technical dossier. The type and amount of data to be provided depend, among other things, on the registered quantity. The information requirements for registration under REACH have generated new information on the toxic and ecotoxic effects of many substances over the past 15 years that was previously not available. Based on the data on the hazardous properties of the substances, registrants have to check which of the various hazard classes and categories should be assigned to the substance. This is done by comparing the information on the hazardous properties of the substances (results of substance tests) with the criteria for the hazard classes and categories in the CLP Regulation. This process is called classification. Depending on the outcome of the evaluation of the hazardous properties, registrants may still need to define additional measures for the safe use of these substances.

1.3.2.3 Mixtures

A mixture is a combination of two or more substances that have been deliberately mixed together. Some examples of these are adhesives, plastic granulates or metal alloys.

> *"[...] 'mixture' means a mixture or solution composed of two or more substances;". [...] REACH Article 3.2 and CLP Article 7.8.*

Mixtures do not have to be registered under REACH (but their ingredients may have to be). However, mixtures must also be assessed with regard to their hazardous properties, i.e. classified under chemicals legislation in accordance with the CLP Regulation.

Materially, mixtures often arise in the form of technical materials in waste streams. These can be, for example, more or less defined building materials, technical materials in articles such as electrical appliances or vehicles, or other streams such as glass, plastics or metals. A special feature of the recycling of materials (i.e. the renewed transition of materials from waste law to chemicals legislation) is that, unlike in primary production, mixtures can also be "produced".

By definition, recycling is considered to be manufacturing in terms of Article 3 REACH. Thus, a recycler is considered a manufacturer in accordance with REACH and, therefore, has to fulfil all the legal obligations of such an actor. However, he may be exempted from the obligation to register the manufactured (recycled) substances according to REACH if he can fulfil the conditions of Article 2 (7d)[14] .

[14] See also "Guidelines on waste and recovered substances" https://echa.europa.eu/documents/10162/23036412/waste_recovered_de.pdf/991bc07a-7c64-4d2a-9aa0-6d8079a424fb

1.3.2.4 Articles

In distinction to substances and mixtures, REACH and CLP define articles as a third category. For these, the function is predominantly determined by the physical and not the chemical properties. For example, a molten metal alloy is a mixture, while a rolled flat sheet is an article.

> *"[...] 'article' means an object which during production is given a special shape, surface or design which determines its function to a greater degree than does its chemical composition;" [...] Article 3.3 REACH.*

Articles do not have to be registered or classified. This is also true if they contain hazardous substances. However, substances contained in articles may have to be registered if they are intentionally released from them (cf. Art. 7 REACH), e.g. ink from a printer cartridge.

For substances of very high concern (SVHC) contained in articles in concentrations above 0.1% by weight, there is a notification obligation for the suppliers of these articles if the SVHCs are contained in the articles in a quantity of more than one tonne per year each. Notification to ECHA can be waived if a release over the entire life cycle can be clearly excluded. In this context, the life cycle generally includes the foreseeable treatment in the waste phase. Furthermore, according to Article 33 REACH, information obligations exist in the supply chain if articles contain one or more SVHCs in concentrations > 0.1% by weight.

1.3.3 Central subject of regulation in waste legislation

The legal basis for the treatment of waste and thus also for the obligation to classify waste is Directive 2008/98/EC (Waste Framework Directive, WFD) and its national implementation in the Circular Economy Act (KrWG[15]).

Waste is defined here as (see Article 3, Paragraph 1. WFD, or § 3 (1) KrWG):

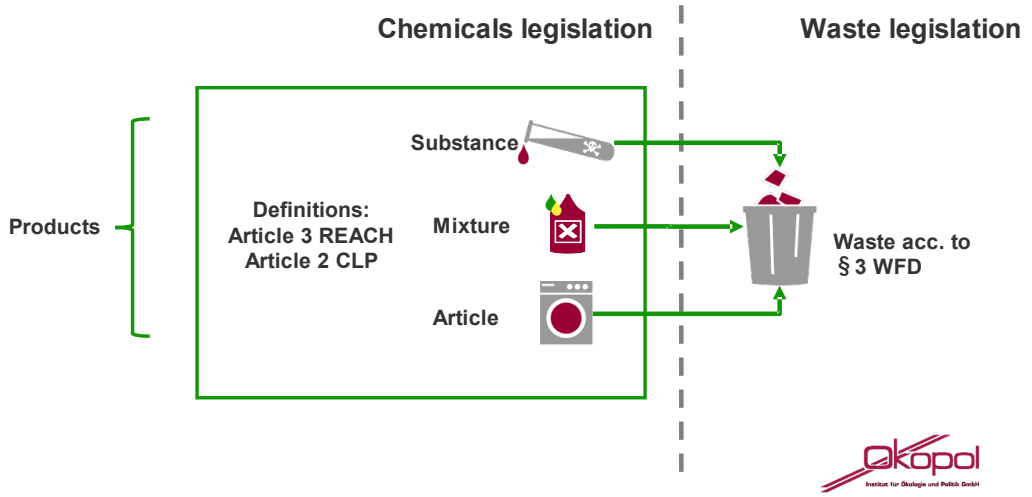
"[...] 'waste' means any substance or object which the holder discards or intends or is required to discard;;".

Thus, if a "substance" or "object" becomes waste through disposal, it loses its legal status as a substance, mixture or article.[16] Figure 21 shows this transition again in schematic.

[15] https://www.gesetze-im-internet.de/krwg/index.html#BJNR021210012BJNE004901000

[16] See also Guidance on the interpretation of key provisions of Directive 2008/98/EC on waste https://ec.europa.eu/environment/pdf/waste/framework/guidance_doc.pdf

Figure 21: Transfer of products into the scope of waste



Source: Own representation, Ökopol

Waste legislation follows its own approach to further differentiate waste. As already mentioned, the composition of waste can vary to a greater or lesser extent, but the respective waste actually produced is considered in its entirety. Within the framework of a "typification", it is assigned to the entries of the European Waste Catalogue (EWC).

According to the basic obligations laid down in §7 KrWG, it is incumbent on producers and owners of waste to recover it (§7(2) KrWG). This recovery must be carried out properly in accordance with the applicable legal ordinances and without causing harm (§7(3) KrWG). If recovery is not possible, the waste must be disposed of in a manner compatible with the public welfare (Article 15 KrWG).

Wastes are also classified. This classification is partly based on the substances contained. The procedure has certain similarities with the procedure for substances and mixtures under CLP and also partly references the classifications for the substances contained in the waste. Nevertheless, the two procedures are only comparable to a limited extent due to various differences in the classification of wastes according to the List of Wastes Ordinance (AVV) and the classification of substances and mixtures according to CLP (for details see chapter 2.2.1 and 2.2.2.)

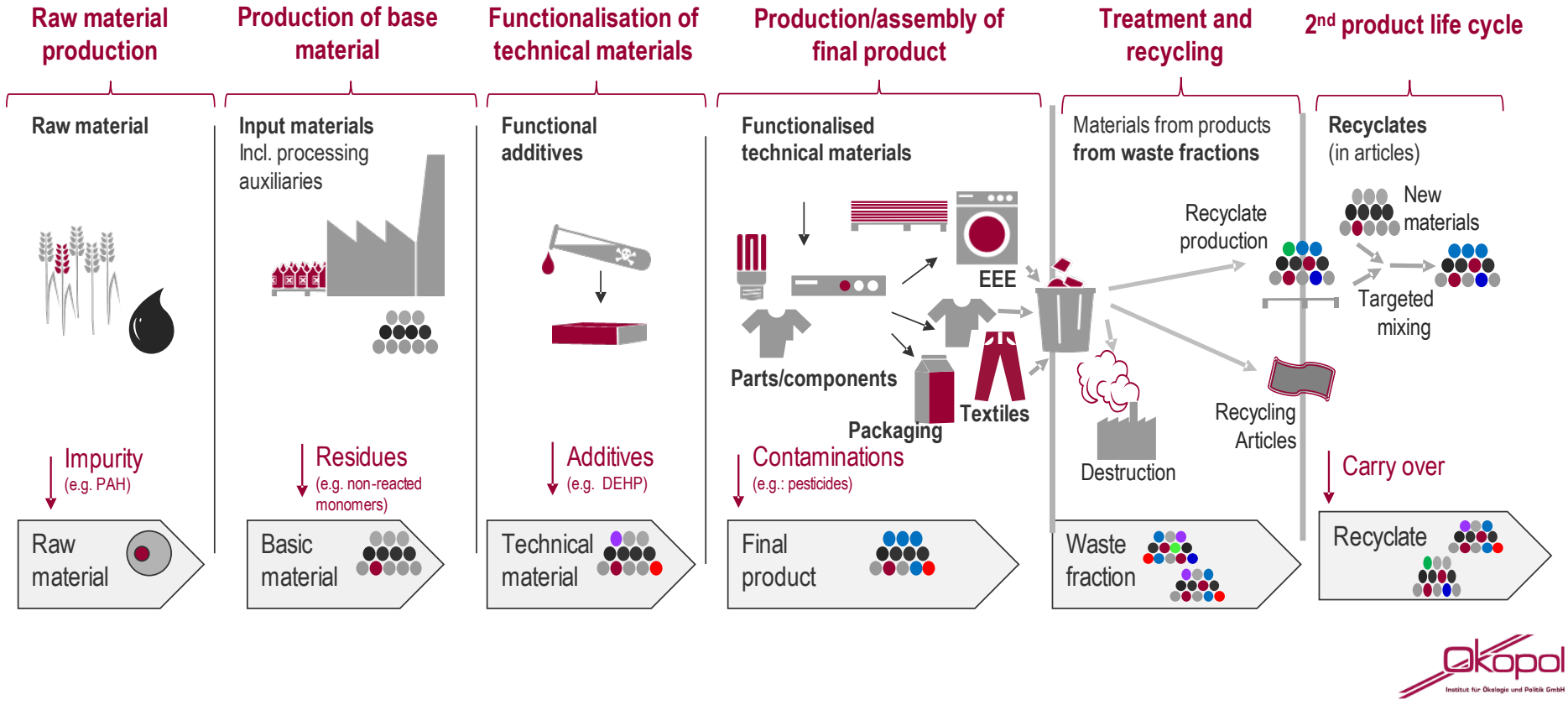
1.3.4 Input of problematic substances into the product and waste stream

In principle, articles, mixtures and also waste may contain substances that are "problematic", which under unfavourable conditions can lead to harm to human health and/or damage to the natural environment.

Particularly in chemicals legislation, but also in waste legislation, there are differentiated concepts of how the "hazardous" substance properties are identified, classified and conceptualised (cf. the more detailed explanations in the sections 2.2.1and 2.2.2).

Before discussing the similarities and differences between these concepts, it is important to realise that such "problematic" substances can enter a product or material stream at all stages of the life cycle. The following diagram shows some examples.

Figure 22: Entry pathways of problematic substances into material, product and waste steams



Source: Own representation, Ökopol

Knowledge of these possible entry points into a specific material stream is of relevance. With regard to possible measures to identify and reduce the corresponding inputs of problematic substances - and thus also to the addressees of corresponding regulations - a distinction must be made between, on the one hand, unintentional inputs and, on the other hand, targeted or deliberately added substances.

- Substances of concern may be unintentionally introduced, e.g. as impurities from raw material extraction, as residues from manufacturing processes or as inputs during or through product use (cross-contamination), but also when mixed with other wastes during disposal.
  The unintentional input of substances of concern is sometimes knowingly, but sometimes also unknowingly "accepted", as the prevention of these inputs or the separation of problematic substances from the material, product and waste flows is not possible or only possible with increased effort.
- Intentional inputs, on the other hand, are practically always made with the aim of influencing the (technical) properties of the mixtures, materials and products accordingly ("functionalisation").

It can be assumed that actors who use substances, e.g. for the functionalisation of technical materials, know these substances and their properties. They thus have the necessary prerequisites to carry out risk assessments or evaluations themselves (or have them carried out) or to pass on information about the presence of these substances to other actors so that the actors can then carry out the corresponding considerations. The possibilities and limitations of sharing such information in the supply and use chains can be found in section 3 of this report.

The situation is quite different with regard to substances that enter a material stream as impurities in raw materials, as residues from manufacturing processes or as a result of cross-contamination during use or the waste phase. It cannot be assumed that the actors have a systematic and comprehensive knowledge of which substances are present in the product, material or waste. It is true that within the framework of quality assurance measures, among other things material flows are sometimes analysed on the basis of random samples. However, in many cases only sum parameters are analysed, but not the individual substances contained.

Substance manufacturers and importers are an exception here. For registration, they must determine the composition of their products (substances) comparatively precisely and, for example, consider impurities in the classification of hazardous substance.[17] This is also the case when it comes to substances consisting of several compounds, including the UVCBs.

Details on the composition of a substance, including impurities, however, are not always mandatory to communicate further down the supply chain. The manufacturers of mixtures use the information from the suppliers of their raw materials (substances and mixtures) for their communication. With the safety data sheet (SDS), they indicate the identity and classification of the ingredients classified under chemicals legislation, provided these are relevant for the classification of the mixture. In addition, the classification of the mixture (see chapter 3.2.1) shall be communicated. Information on impurities that are not explicitly identified is thus missing in the entire subsequent supply chain (up to the articles).

[17] This is done "automatically" because the substances are subjected to the (eco-)toxicological tests as they are produced. What part an impurity has in the classification is not determined, but the substance as such is tested.

1.3.5 Risks and risk management along the material streams

Whether or not the presence of substances with properties that are harmful to the environment or health in a product or material stream is problematic depends on whether humans and/or the environment come into contact with the substance, i.e. whether exposure occurs at a sufficient level and for a sufficient duration. According to the practice in chemicals legislation, for example, a health risk exists if the dose of a substance that a person takes in (exposure) is higher than the dose that causes harm (hazard). This applies analogously to the environmental compartments.

In order to assess the possible occurrence of damage to the environment and health by a substance (in a specific use), the method of risk assessment is established in chemicals legislation. In order to determine a risk, on the one hand the concentration/dose above which a substance has a harmful effect, e.g. a toxic effect (effect threshold), is determined. On the other hand, the possible exposures (of the different uses) are estimated in order to determine the quantity in which substances are released from materials, products or waste and the concentrations or doses to which humans or the environment are exposed as a result (exposure level).

Quantitatively, a risk is estimated by calculating the "Risk Characterisation Ratio" (RCR). For this purpose, the modelled or measured exposure level[18] is set in relation to the determined effect threshold[19] . The RCR is calculated by dividing the exposure level by the effect threshold. If the RCR is greater than the value 1, a risk is assumed, and a use is to be considered unsafe under the assumed conditions. An RCR > 1 results in the obligation to either discontinue the use or advise against it in the supply chain, or to take additional exposure-reducing measures that reduce the modelled or measured exposure level and thus lead to the RCR becoming less than 1.

For substances with certain properties, it is not possible to derive an effect threshold at which exposure does not lead to harmful effects.[20] Risk management for such substances envisages, if possible, elimination of the risk, e.g. by banning the substance or minimising the risk as far as possible by reducing exposure to an unavoidable minimum.

Both in the determination of effect thresholds and in the assessment of exposure, a distinction is made between intake pathways and the frequency and duration of exposure. This means that with regard to human health, there are different effect thresholds for intake by inhalation, ingestion and skin contact as well as short-term (infrequent) exposure or long-term (constant) exposure. When determining environmental exposure, the distribution of the substance as well as the transformation by chemical and biological processes is taken into account.

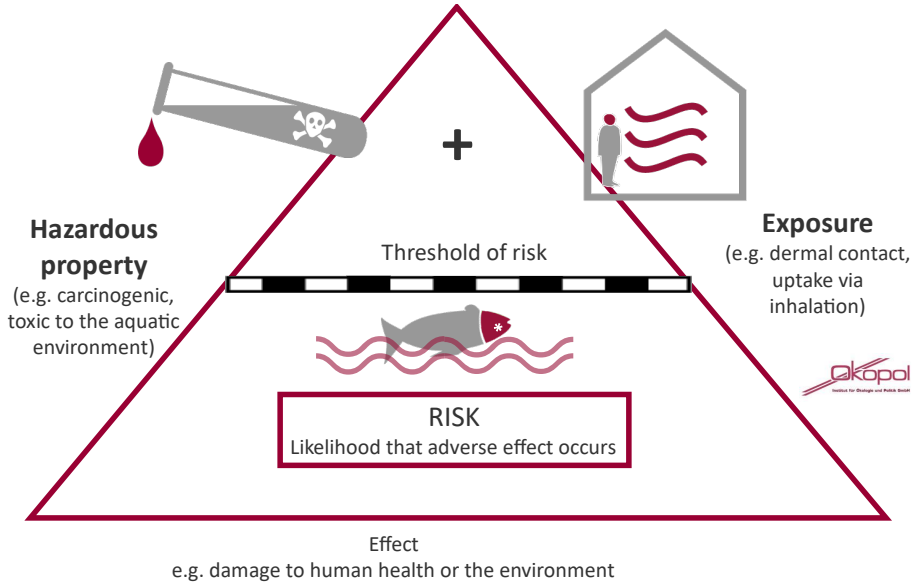
The following figure again schematically shows the factors influencing a material risk.

[18] Predicted Environmental Concentration (PEC) in the environmental context, exposure in the field of human health

[19] In the environmental context, this is referred to as Predicted No-Effect Concentration (PNEC) in the context of human health as Derived No-Effect Level (DNEL).

[20] In the environmental sphere, these are, for example, persistent, bioaccumulative and toxic as well as very persistent and very bioaccumulative substances (PBT/vPvB). In the health sector, these include many carcinogenic substances.

Figure 23: Influencing factors and terminology in substance-related risk identification



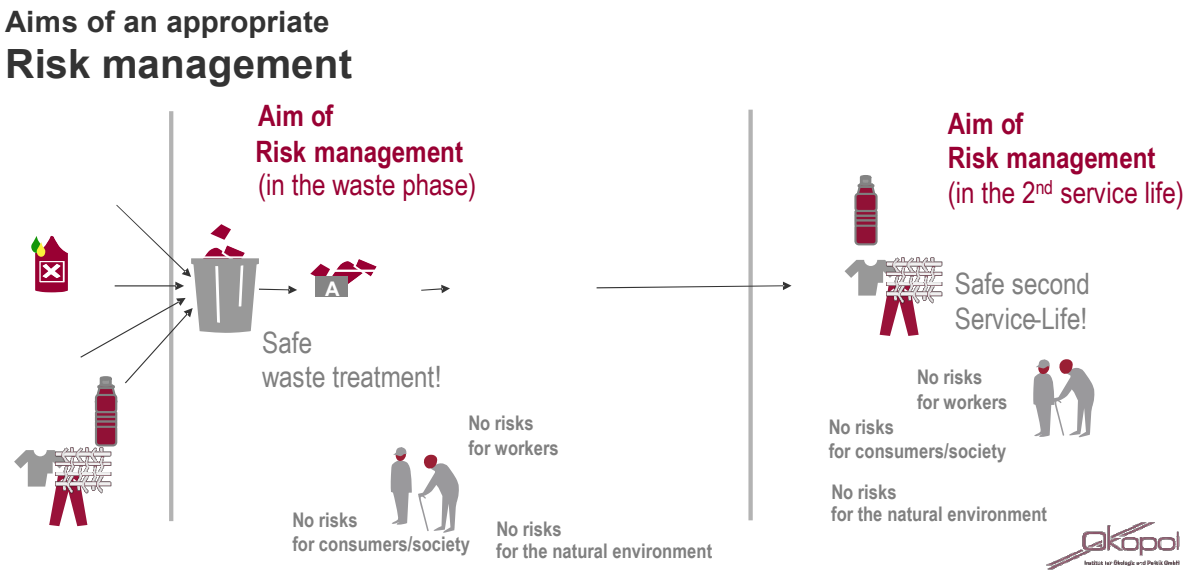
Source: Own representation, Ökopol

The basis of the exposure assessment is the consideration of the life cycle of a substance and the life cycle steps in which a release from materials, products and waste may occur and in what frequency and quantity.

Risk assessment in chemicals legislation aims to avoid substances being used in products for which safe use (presence of an unacceptable risk) is not possible. The exposure assessment can identify problematic uses or life cycle steps. This is the basis for the derivation of risk management measures (RMMs), which can range from the prohibition of a use to specifications for emission and exposure limitation through technical measures to concrete specifications for the handling of products.

In order to ensure the safe use of substances, each life cycle stage or several cycles of a circular economy must be taken into account in risk assessments and, if necessary, shaped by RMMs. The objectives are recurring. The aim is always to ensure that there is no risk to the (general) population, to employees and to the natural environment. The following diagram (Figure 15) shows this schematically.

Figure 24: Aims of risk management at the different steps of the circular economy



Source: own representation, Ökopol

The focus of the assessment by the various actors who have to carry out this assessment according to chemicals legislation differs depending on the life cycle phase:

- Primary manufacturers of substances are responsible for assessing safe use throughout the life cycle and, where appropriate, eliminating uses that pose risks. This assessment includes the first product use phase (service life). The so-called "chemical safety assessment" must be carried out as part of the substance registration for all chemical substances registered in quantities above 10 t/a (REACH Article 14). The creation of exposure scenarios and the calculation of the exposure resulting from the use, including the resulting risks for humans and the environment, must also be carried out in this step whenever the substance fulfils the criteria for a PBT/vPvB substance and/or has hazardous properties.
- The safe use during service life should also be assessed by the placers on the market of products, including with regard to the chemicals it contains (according to the EU Directive on General Product Safety, or the Food and Consumer Goods Law in Germany). However, there is no standardised procedure and/or methods and instruments to support product manufacturers.[21]
- The actors in the waste treatment chain have to decide which treatment processes are suitable to avoid risks from waste treatment. For this they need information about which hazardous substances are contained in the end-of-life products. Risks can arise from the handling of waste during treatment when substances are released through collection, transport, sorting and treatment (employees, environment).

In a possible second service life, it must be taken into account that the uncontrolled "carry-over" of substances with hazardous properties from the waste stream into recycled materials means that safe use is only possible to a limited extent. The possible carry-over of substances may result in a subsequent "non-intended" use of these substances for the (secondary) products

[21] Moreover, the assessment according to the Product Safety Directive only refers to the fact that the product users should not be harmed. Possible environmental risks do not have to be determined.

made from recycled materials[2223] . Here, too, knowledge of the presence of hazardous substances and their associated properties is central to the assessment of possible risks and their avoidance.

[22] For registration under REACH, registrants evaluate the uses of a substance. If a use is assessed as "safe", i.e. no unacceptable risks are identified, the registrant "identifies" it as a use (it is therefore supported) and communicated at least by name with the SDS. Uses that are not intended are those that are "not identified" and thus not covered by the chemical safety assessment of the original substance manufacturers or are still assessed as "not safe" in the chemical safety assessment despite iterative processes, or uses that the registrant explicitly does not support ("uses advised against" cf. section 3.7 Annex VI of REACH).

[23] Systematically, the disposal of these products from secondary materials again results in the risk of endangering humans and the environment through the previously "carried over" problematic substances.

2 Expert Dialogue 1 - Interlocking between chemicals and waste legislation

2.1 Thematic focus

In both chemicals and waste legislation, the hazards that can be posed by substances and mixtures or by waste are examined and assessed. Classification of substances and mixtures as well as waste as "hazardous waste" leads in both areas of legislation to prioritisation in the examination and implementation of corresponding legal consequences including the underlying risk management for the safe handling of the hazardous ingredients present.

However, the subjects of regulation and the framework conditions in chemicals and waste legislation differ in many respects. Apart from some similarities in classification, there are relevant differences in the testing and assessment of wastes and substances and mixtures as well as the result - a classification as "hazardous".

At the interfaces between the regulatory areas, this can result in deviations in risk management that require explanation, legal ambiguities and, in individual cases, substantial material differences. These pose challenges for both the market players and the government agencies involved in the implementation of the regulations

2.2 Technical background

In the following, the different procedures for the classification as "dangerous" are presented in a more differentiated way:

2.2.1 Classifications in chemicals legislation

The manufacturers and importers of chemical substances collect and generate substance data for registration under REACH in order to determine the hazardous properties of their substances. This information is used for chemical classification according to the requirements of the CLP Regulation. The CLP Regulation transposes the Globally Harmonised System (GHS)[24] into European legislation. The CLP Regulation defines the rules for the classification of both substances and mixtures. These rules are also referenced in the classification of waste, as explained below.

Substances that are manufactured or imported in larger quantities than 10 t/a must also be subjected to a chemical safety assessment by the manufacturers or importers in accordance with Article 14 REACH. In addition to the derivation of effect thresholds for the identified hazardous properties, this also includes the examination of a particular environmental hazard posed by these substances, namely whether they are persistent, bioaccumulative and toxic (PBT) or very persistent and very bioaccumulative (vPvB). The threshold values for the above criteria are set out in Annex XIII of REACH.

[24] Cf. United Nations Economic Commission for Europe (UNECE) https://unece.org/about-ghs

"Hazardous substance properties"

The CLP Regulation defines four main hazard groups:

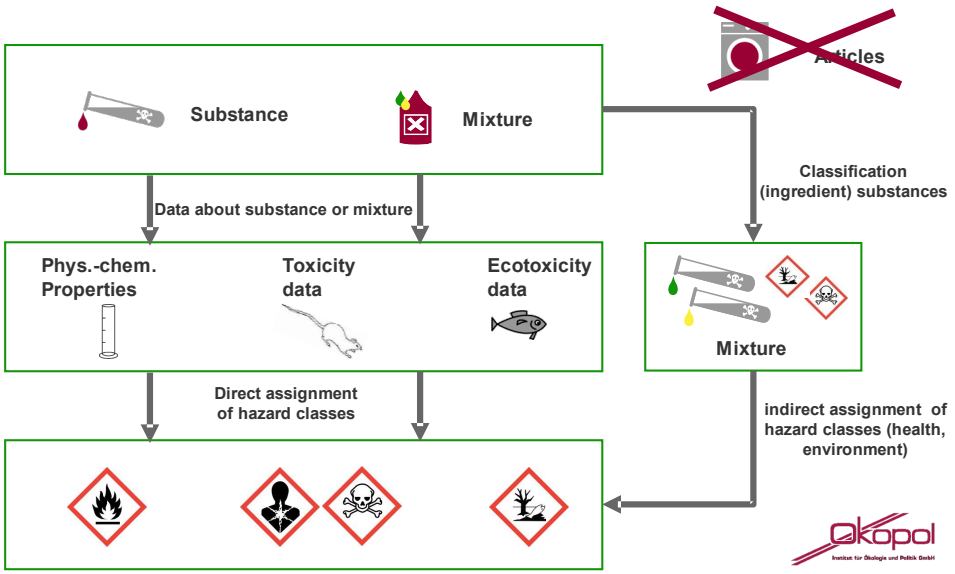
- Physical hazards,
- Health hazards,
- Environment hazards, und
- Other hazards

each of which comprises different hazard classes and categories and can be found in Annex I of the CLP Regulation (cf. Figure 25.)

Article 3 of the CLP Regulation states:

> *"Hazardous substances and mixtures and specification of hazard classes*
>
> *A substance or a mixture fulfilling the criteria relating to physical hazards, health hazards or environmental hazards, laid down in Parts 2 to 5 of Annex I is hazardous and shall be classified in relation to the respective hazard classes provided for in that Annex.*
>
> *Where, in Annex I, hazard classes are differentiated on the basis of the route of exposure or the nature of the effects, the substance or mixture shall be classified in accordance with such differentiation."*

Figure 25: System of classification and labelling according to the CLP regulation



Source: own representation, Ökopol

Every person placing a substance or mixture on the market must classify and label it according to Article 4 of the CLP Regulation. For this purpose, all available data on the hazardous properties of substances must be used, e.g. from the registration dossier and the scientific literature. Mixtures are partly classified based on the properties of the hazardous ingredients they contain and some properties, particularly those regarding physicochemical hazards, have to be determined by independent tests. The classification of substances and mixtures by those placing them on the market is referred to as self-classification. The quality of self-classifications

depends on the availability of data on substance properties and the expertise of the companies classifying the substances (and mixtures).

The result of the classification process for substances (as well as any necessary changes to classifications due to new information) must be reported to ECHA for inclusion in the Classification and Labelling Inventory.[25]

For certain hazardous properties, ECHA and Member State authorities may follow a second route to determine the classification of substances, called harmonised classification. A harmonised classification by the EU and the authorities of the Member States is mandatory as a minimum classification for the placer on the market of the substance concerned. Similarly, companies can request a harmonised classification for a substance or the modification of an existing entry if new information on intrinsic properties of the substance is available.

Depending on the available data and the specific composition of a substance, the results of the self-classifications of the placers on the market may differ both among themselves and in relation to the harmonised classification. This may also have an impact on the classifications of mixtures.

Substances of very high concern

Substances of very high concern (SVHC) are substances that fulfil the criteria of Article 57 REACH and have been included in the so-called candidate list for authorisation[26] in a formal procedure according to Article 59 REACH. The criteria of Article 57 REACH are:

- Carcinogenicity, mutagenicity or toxicity for reproduction (CMR) of category 1A or 1B according to CLP Regulation,
- Persistence, Bioaccumulation and Toxicity (PBT) or High Persistence and High Bioaccumulation (vPvB) according to the criteria in REACH Annex XIII or
- Identification of a similar concern in the context of case-by-case assessments; a similar concern exists, for example, for substances with an endocrine disrupting mechanism of action or sensitising properties

Substances that fulfil the criteria of Art. 57 REACH but are not included in the candidate list are not designated as SVHC. There is a common understanding across the EU that the risks of SVHCs need to be particularly controlled, which includes the waste phase.

Persistent organic pollutants (POPs)

The Stockholm Convention on Persistent Organic Pollutants is a UN treaty to protect human health and the environment from chemicals that remain in the environment over long periods of time, are geographically widespread, accumulate in the fatty tissues of humans and wildlife, and have adverse effects on human health or the environment. The properties fulfilled by substances regulated as POPs under the Stockholm Convention[27] are similar to those of PBT/vPvB substances addressed under Art. 57 REACH[28]. Substances fulfilling the PBT/vPvB criteria can be identified as SVHC and included in the REACH candidate list (see above). These substances can,

[25] https://echa.europa.eu/regulations/clp/cl-inventory

[26] https://echa.europa.eu/de/candidate-list-table

[27] Stockholm Convention on Persistent Organic Pollutants (POPs) http://www.pops.int/TheConvention/Overview/TextoftheConvention/tabid/2232/Default.aspx

[28] Probably always when Art. 57 (f) is considered. However, as a rule, the criteria of Annex XIII of REACH already apply for the assignment of substance properties according to Art. 57 (d) PBT and (e) vPvB.

among other things, be restricted or made subject to authorisation under REACH and/or (subsequently) also be put forward for regulation at international level under the POPs Convention. Conversely, the Convention and its requirements, including the requirements for the treatment of waste containing POPs, are implemented in the EU POPs Regulation.[29]

Article 7 in conjunction with Annexes IV and V of the POPs Regulation are particularly relevant for waste treatment. This sets limits for POPs within the scope of the Regulation above which recycling is not permitted. In these cases, the POPs in the waste must be destroyed or irreversibly transformed (cf. Article 7 of the POPs Regulation).

Substances of concern

The term "Substance of Concern" (SoC) is not defined in chemical legislation. In the EU Commission's Chemicals Strategy for Sustainability, substances of concern are defined as follows:

> *"These include, in the context of this strategy and related actions, primarily those related to circular economy, substances having a chronic effect for human health or the environment (Candidate list in REACH and Annex VI to the CLP Regulation) but also those which hamper recycling for safe and high quality secondary raw materials."*

This designation thus includes substances that are either chronically harmful to the environment and health or disrupt the circular economy.

2.2.2 Procedure for the classification of a waste as "hazardous waste" within the scope of waste legislation

The classification of waste follows the procedure laid down in the Ordinance on the List of Wastes (AVV). This procedure requires that a clear designation be assigned to the waste: This is referred to as waste classification. The designation results from the assignment of a 6-digit waste code as defined in Commission Decision 2000/532/EC[30], the European List of Waste (LoW). The LoW was last updated by Decision 2014/955/EU[31] and adapted to the modified requirements of chemicals legislation when the CLP Regulation[32] came into force. It has been implemented nationally by the AVV.

The LoW is subdivided into 20 chapters, each of which is subdivided into numerous groups (4-digit) and waste types with six-digit waste codes. The lowest level specifies a concrete waste.

While the groups of waste types serve to further specify the area of origin, they are partly based on the physical form in which the waste is produced (i.e. as sludge, dust, ...) and on further differentiations of the processes of origin or on central constituents.

About half of the waste codes are marked with an "asterisk" as "hazardous waste". In many cases, these are so-called mirror entries for otherwise largely similar types of waste, which are merely marked with the addition "containing hazardous substances". There are also entries that

[29] REGULATION (EU) 2019/1021 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 June 2019 on persistent organic pollutants.

[30] Commission Decision 2000/532/EC "Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Directive 91/689/EEC on hazardous waste (notified under document number C(2000) 1147)" https://eur-lex.europa.eu/legal-content/DE/TXT/?qid=1596804804390&uri=CELEX%3A02000D0532-20150601

[31] http://eur-lex.europa.eu/legal-content/DE/TXT/?uri=celex%3A32014D0955

[32] Regulation 1272/2008 http://eur-lex.europa.eu/legal-content/DE/TXT/?uri=celex%3A32008R1272

target specific hazardous substances and refer to them in the description (e.g. mercury, polychlorinated biphenyls (PCBs), etc.).

In principle, waste producers assign the waste they generate to a waste code. In practice, they often rely on the expertise of a waste management company. Furthermore, for some areas there are further documents from the waste authorities on which the waste owner can base his waste classification (cf. following section). The responsible waste authorities can critically review the classifications at any time within the framework of waste law enforcement.

Some examples of the above chapters of the AVV based on the origin of waste are:

- Various industrial activities (not conclusive, numbers correspond to the chapter numbers of the AVV)
  - 05 Wastes from petroleum refining, natural gas purification and pyrolytic treatment of coal
  - 06 Wastes from inorganic chemical processes 3
  - 07 Wastes from organic chemical processes
- Waste from municipal waste collection (household waste),
  - 20 Municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions
- Hospital waste
  - 18 Wastes from human or animal health care and/or related research (except kitchen and restaurant wastes not arising from immediate health care)

To facilitate classification, the waste codes are explained by means of short descriptions, such as the note "containing hazardous substances", for waste codes with an asterisk "*".

Based on the waste origin, three cases are possible. A waste of a specific origin:

- Is absolutely not hazardous. This applies, for example, to all municipal waste that is not collected separately in Germany, such as bulky waste or waste disposed of in the "grey bin".
- Is absolute hazardous. Thus, in chapter 13 of the AVV, all oil wastes are classified as hazardous. There are no entries for non-hazardous waste in this chapter.
- May be classified as hazardous or non-hazardous, i.e. so-called "mirror entries" exist. In these cases, classification is based on the ingredients in the waste.

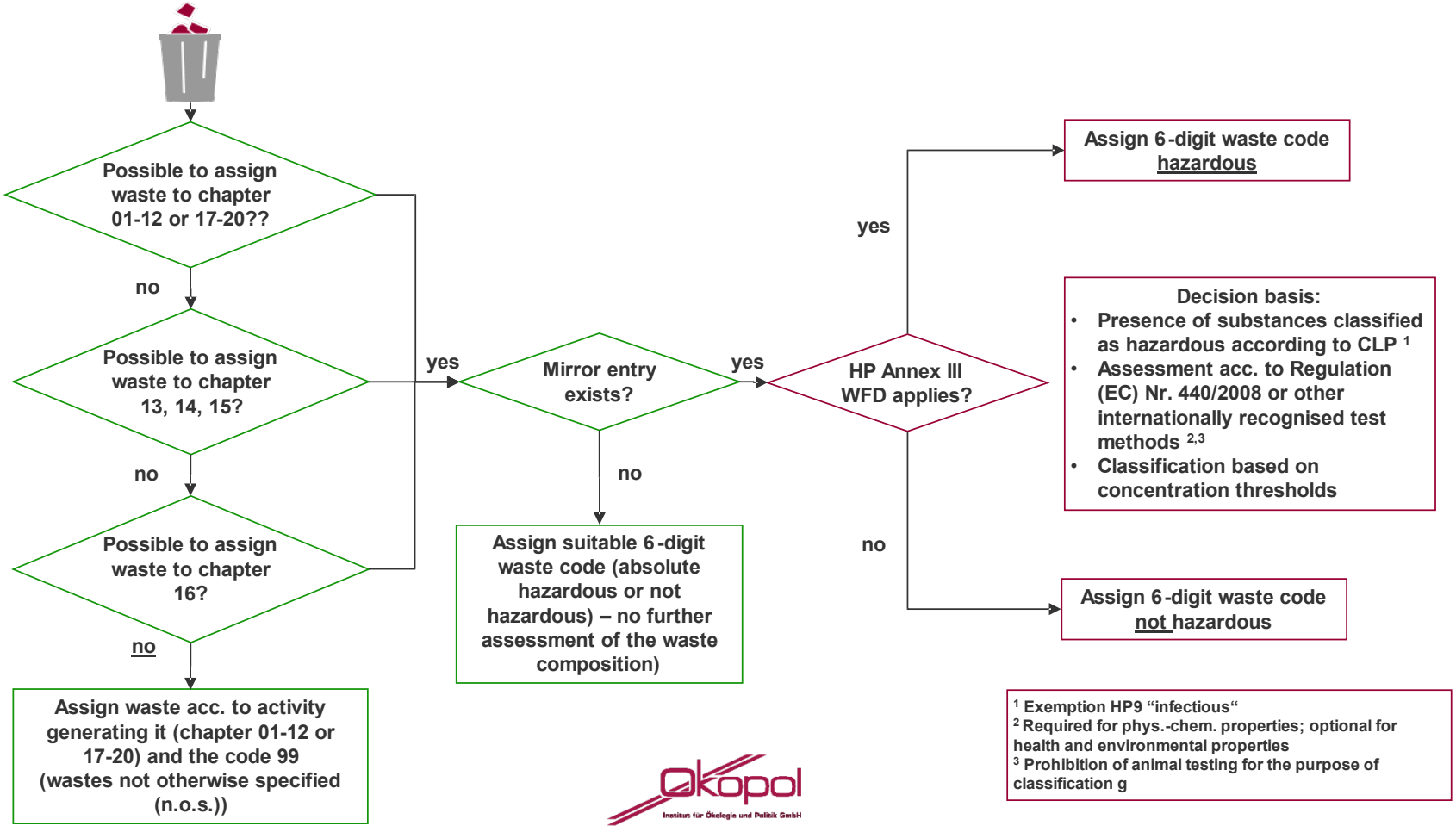
The determinations as to which wastes belong in which categories are made for the first and second of the cases presented above by authorities on the basis of their knowledge of typical compositions. For the classification of the waste as "hazardous" (mirror entry), it is sufficient if one HP criterion is fulfilled. This applies to all hazardous wastes (see Article 3(2) AVV in conjunction with Article 3(5), sentence 1). Risk considerations also play a role here:

- Can people be harmed during waste collection and treatment?
- Can pollutants be released during waste treatment and enter the environment?

If a waste falls into the third case (hazardous or non-hazardous), the correct entry must be determined in each case: Waste is then classified on the basis of its constituents, which is described in more detail below. The flow chart in the following diagram (Figure 26) illustrates this procedure (see Annex AVV Section 3ff.):

- The first step is to check whether the waste can be assigned to a specific activity or source (without the waste codes ending in 99 in these chapters, see below). Chapters 01 to 12 or 17 to 20 characterise individual sectors such as agriculture or various industrial activities as well as other relevant sectors, e.g. municipal waste.
- If in this step no assignment is possible, it is first checked whether an assignment for very specific waste types is possible:
  - Oil waste and liquid fuel waste,
  - Wastes from organic solvents, coolants and propellants
  - Packaging waste, absorbents, wipes, filter materials and protective clothing
- In a third step, the allocation to Chapter 16 of the AVV is checked, in which a wide variety of waste types are collected. This largely represents end-of-life vehicles and electrical appliances, but also includes wastes that cannot be assigned to any other chapter or group.
- Only if there is no possibility of assigning a waste to a specific waste type based on these tests is the waste assigned to an undefined collection category. This is done using the waste codes ending in 99 that were blanked out in the first test steps. The chapter that originally characterised the origin of the waste must be selected (at the beginning of step 1).

Figure 26: Decision tree for waste classification: Green (left): based on waste generating activity and waste type and red (right): based on the ingredients



Source: own representation based on EAV/AVV, Ökopol

The classification of waste with regard to the selection of mirror entries based on the ingredients is carried out following the classification of mixtures under chemical legislation (see Section 4.1). The legal basis for this is Annex III of the EU WFD (direct reference of the AVV)[33] , which defines the criteria for the so-called "Hazardous Properties" (HP). These criteria cover the hazardous properties in a similar way as is done in chemicals legislation.

The physical properties HP 1 - HP 3 can be determined by tests, in analogy to mixtures. This is limited by the phrase „[...] *in so for this is appropriate and proportional*". If the content of hazardous chemicals of certain classes indicates that the respective HP criterion is fulfilled, this can already be sufficient to classify a waste with the mirror entry.

The environmental and health hazards of wastes resulting from the harmful effects of the constituents are mostly determined on the basis of the chemical classifications of these substances using the concentration limits specified in Annex III. If, for example, a waste contains a carcinogen of category 1A or 1B above the threshold of 0.1 % (by weight), the waste is to be classified as hazardous according to HP 7.

The environmental and health-related HP criteria are similar to the categories of the CLP Regulation but are not a 1:1 implementation of them: In some cases, different concentration thresholds apply and/or different rules apply when several substances with the same property are present in a waste. As an alternative to classification on the basis of concentration thresholds, it is also possible to test a waste for its hazardous properties for criteria HP 4 - HP 8 and HP 10 - HP 14. However, due to the ban on testing with vertebrates, this possibility is limited.

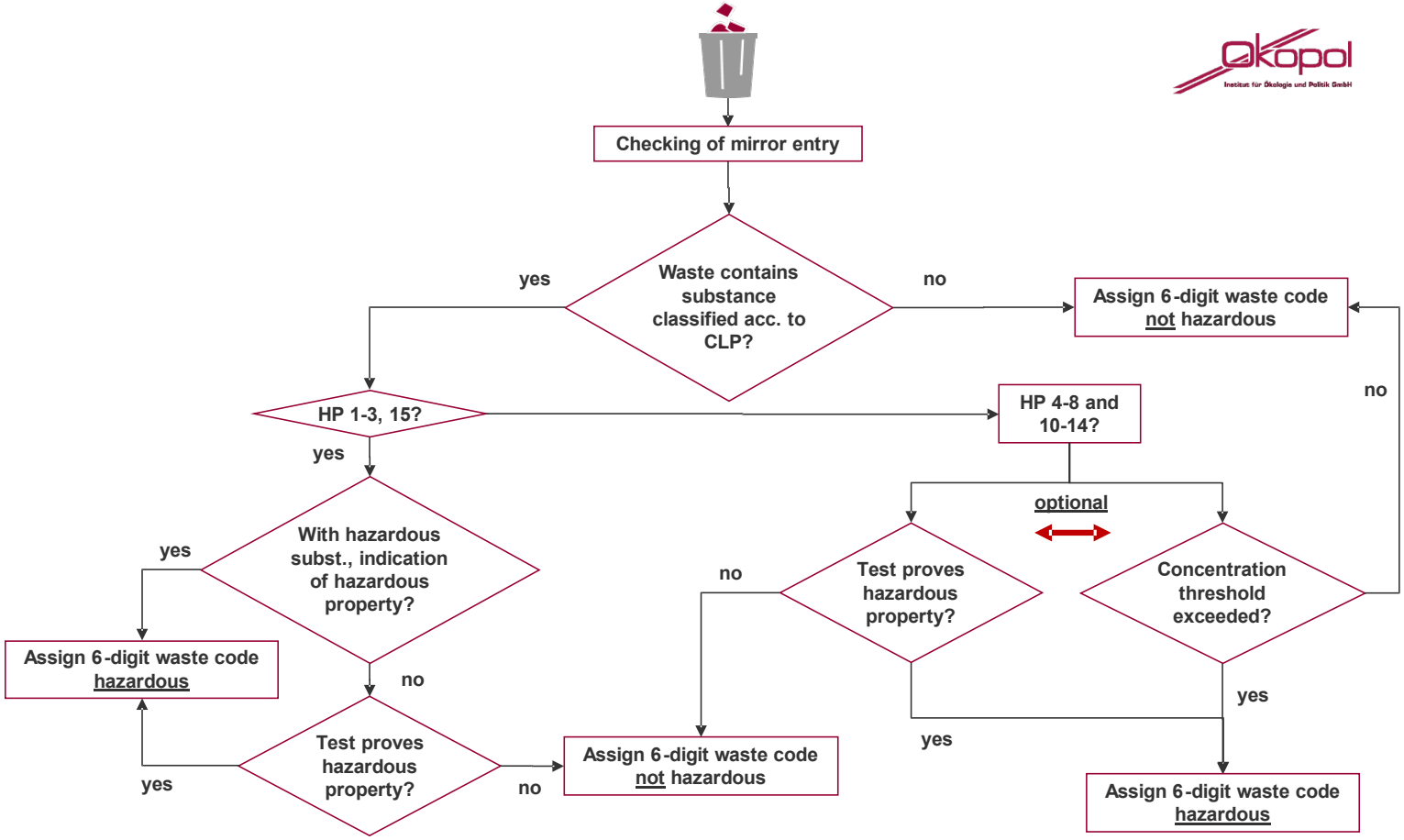
HP 9 "infectious" is a special case, as this HP criterion is implemented in the Member States independently and with regard to the relevant (national) requirements in the health sector.

HP 15 is based on the one hand on the classifications from the CLP system as well as on the individual assessment from a waste-specific perspective. Thus, a separate consideration in analogy to HP 1-3 is also required here.

An overview of the procedure for the classification of wastes according to HP criteria is shown in Figure 27.

[33] Annex III of the EU Framework Directive as amended by Regulation (EC) No 1357/2014[33] (as of March 2021).

Figure 27: Assigning mirror entries according to the GCU using Annex III WFD



Source: own representation, Ökopol

The requirements for waste classification by composition may be deviated from in the following cases.

- According to § 3 AVV, the competent authorities or the waste producers/owners may designate a waste as non-hazardous by derogation from the AVV if they do not consider any of the HP criteria listed in Annex III WFD to be fulfilled.
  Conversely, it is possible to classify a waste as hazardous by derogation from the AVV if the competent authorities or the waste producers/owners consider at least one of the HP criteria as fulfilled.
  In both cases, the EU Commission must be informed

- If a waste is tested for its hazardous properties in accordance with the test regulations introduced under REACH[34] or other internationally recognised test methods, the test result takes precedence over classification based on information about the constituents. The legal basis for this procedure is the procedure for the classification of waste described in the AVV.

In addition, the AAV requires that waste containing certain named POP substances (above the levels set out in Annex IV of the POPs Regulation) be classified as hazardous. These are:

1. polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF),
5. 1,1,1-trichloro-2,2-bis(4-chlorophenyl)ethane (DDT),
6. Chlordan,
7. Hexachlorocyclohexanes (including lindane),
8. Dieldrin,
9. Endrin,
10. Heptachlor,
11. Hexachlorobenzene,
12. Chlordecone,
13. Aldrin,
14. Pentachlorobenzene,
15. Mirex,
16. Toxaphene,
17. Hexabromobiphenyl or
18. PCB.

This regulation does not apply to other POP substances. However, the applicability of the HP criteria must be checked, which is likely to be relevant especially for HP14 "dangerous for the environment", at least at higher concentrations. However, the limit values of the HP criteria are often above (in the case of HP14 2500 mg/kg) the values in Annex IV POP Regulation (in the case of the above-mentioned ≤ 50 mg/kg, or for dioxins/furans 15 µg I-TEQ/ kg[35]).

2.2.3 Practical implementation of waste classification

The end of the 1st life cycle of products represents a crucial handover point of information on hazardous substances at the interface "product→ waste", as this is important for the classification of a waste as hazardous or non-hazardous. In this context, substances, mixtures and articles differ in terms of the information available at that point. Substances and mixtures

[34] Regulation (EC) No 440/2008 http://eur-lex.europa.eu/legal-content/DE/TXT/?uri=celex%3A32008R0440 (animal testing must not be carried out in this context).

[35] 17 Individual substances from polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/PCDF), 2,3,7,8 - tetrachlorodibenzo-para-dioxin, so-called Seveso dioxin as most toxic component. Indication in I-TEq: International toxicity equivalents related to the so-called Seveso dioxin 2,3,7,8-TCDD, calculation according to NATO/CCMS.

are classified according to the rules presented and the central information on hazardous ingredients is communicated in the SDS as well as on the packaging label in the supply chain.

Articles are not classified under chemical legislation and there is no obligation to pass on information about ingredients classified as hazardous in an accompanying document or label. An exception here are the SVHCs, for which there is an information obligation if their concentration exceeds 0.1% in the article. In addition, since January 2021, actors in the supply chain of articles have to report their content to ECHA's database (see § 16f ChemG).

This results in different situations with regard to the waste. Since waste from the use of chemical substances or mixtures is often similar to them, the hazardous properties according to the SDS or product label from the first life cycle can also be transferred to the waste. Exceptions are mixtures from processes in which new compounds are formed during use (e.g. at high application temperatures). In these cases, however, there is a high awareness of potentially problematic substances, so that the waste is often well examined with regard to its constituents and, if necessary, in some cases already characterised as absolute hazardous due to its origin.

The situation is different for articles, because information on the content of hazardous substances, e.g. in components, is usually not passed on along the supply chain. Furthermore, the existing flow of information is often hampered or interrupted by the service life of the products and therefore does not reach the waste management actors. Thus, there is usually a lack of key information for identifying chemicals-related environmental risks that could potentially arise from the treatment of waste from (end-of-life) articles.

In general understanding, articles that are on the market are also considered "safe" by waste management actors, as it is assumed that all possible risks are already assessed and controlled under chemicals and/or product legislation[36].

It is nevertheless possible that an article, if it becomes waste, is to be classified as "hazardous waste" because it contains hazardous substances, if corresponding mirror entries are available and the classification is based on the HP criteria in Annex III of the WFD.

On the other hand, it is also possible that a waste is classified as "non-hazardous" even though it contains hazardous substances because the AVV only has one entry for the respective waste origin as absolute non-hazardous.

The procedure for classifying waste as hazardous waste (or not) is not always implemented consistently in practice. The following considerations play a role in the waste classification in practice, irrespective of real substance contents:

- Consumer products are generally regarded as "safe" because they could be used for decades without any problems (example: PVC floor coverings containing plasticisers are generally treated as non-hazardous waste, although the plasticiser content should lead to a classification).
- Conversely, certain products are assumed to regularly contain hazardous ingredients, so that they are classified as hazardous per se (e.g. waste electrical and electronic equipment).
- Hazardous substances are not homogeneously distributed in articles. While some materials have high pollutant contents, others are free of them. This is particularly relevant for the

[36] Requirements regarding the presence or absence of hazardous substances can also result from very specific product regulations, such as the Toy Safety Directive (Directive 2009/48/EC).

targeted dismantling of components, e.g. if the outer parts are free of pollutants and inner components contain pollutants (e.g. waste electrical and electronic equipment).

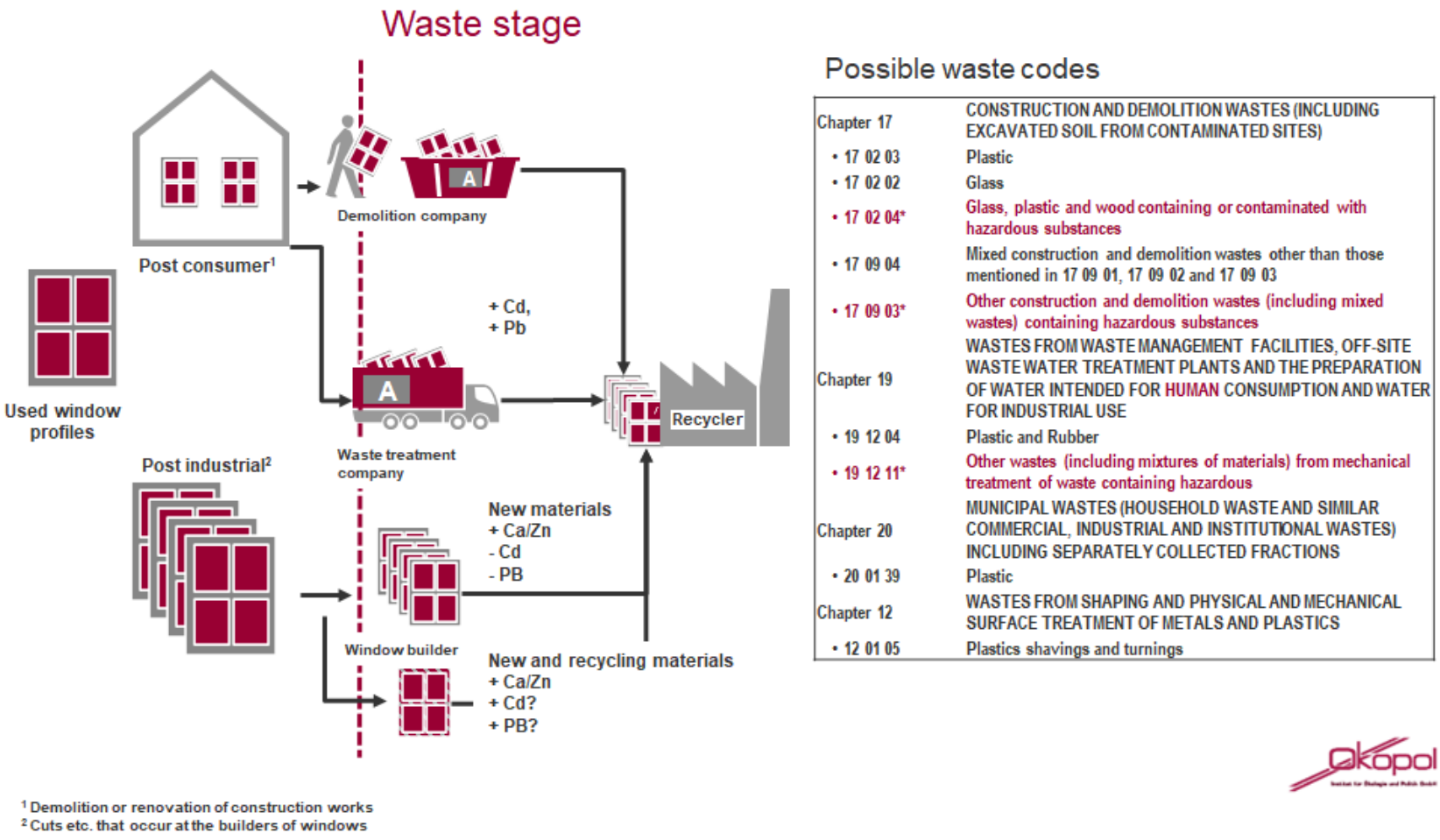
- Hazardous substances are often firmly (covalently) bound in the materials of which the articles are made. This represents a barrier to release under conditions of use.

In practice, the rules for the classification of waste are applied pragmatically, especially when waste consists to a large extent of former products. In these cases, the information on constituents required for classification is not available and would have to be generated at great expense. The same applies, for example, to structures that are not strictly speaking articles under REACH, such as roads or bridges.

Individual pollutants are usually known from regular sampling of the waste (acceptance analytics) or from information provided by the waste producers (usually only applicable to commercial waste). Moreover, the decision on the waste code is often made not only between two mirror entries, but also between different waste chapters, depending on who makes the classification and the role of the actor.

Figure 28 shows possible ways in which waste from window profiles can be classified differently. If the waste from window profiles originates from a renovation project, the demolition company would classify it as "construction and demolition waste" in Chapter 17 of the AVV. After an initial service with a disposal company that sorts and transports the waste, a reclassification based on the source would be possible, for example, and thus the application of the entries according to Chapter 19 "Wastes from waste treatment facilities […]". A window manufacturer who wants to dispose of window profile sections in his workshop might rather use waste codes that reflect his activity and assign a household-related characteristic to the window profiles (Chapter 20), as he does not classify the waste as construction and demolition waste, or use the sections for plastic processing activities (Chapter 12).

Figure 28: Different waste classification depending on the role and activity of the classifying actors



Possible waste codes

Chapter 17	CONSTRUCTION AND DEMOLITION WASTES (INCLUDING EXCAVATED SOIL FROM CONTAMINATED SITES)
• 17 02 03	Plastic
• 17 02 02	Glass
• 17 02 04*	Glass, plastic and wood containing or contaminated with hazardous substances
• 17 09 04	Mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03
• 17 09 03*	Other construction and demolition wastes (including mixed wastes) containing hazardous substances
Chapter 19	WASTES FROM WASTE MANAGEMENT FACILITIES, OFF-SITE WASTE WATER TREATMENT PLANTS AND THE PREPARATION OF WATER INTENDED FOR HUMAN CONSUMPTION AND WATER FOR INDUSTRIAL USE
• 19 12 04	Plastic and Rubber
• 19 12 11*	Other wastes (including mixtures of materials) from mechanical treatment of waste containing hazardous
Chapter 20	MUNICIPAL WASTES (HOUSEHOLD WASTE AND SIMILAR COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL WASTES) INCLUDING SEPARATELY COLLECTED FRACTIONS
• 20 01 39	Plastic
Chapter 12	WASTES FROM SHAPING AND PHYSICAL AND MECHANICAL SURFACE TREATMENT OF METALS AND PLASTICS
• 12 01 05	Plastics shavings and turnings

Source: own representation, Ökopol

However, an industry practice for the classification of recurring waste streams has been established in many cases. The end-of-life windows considered in the example are usually classified with the waste code 17 02 03 plastics. However, the possible pollutant contents are not checked here either, although windows may contain both cadmium and lead and would then have to be handled as hazardous waste (unless this has been refuted by test data).

A "formal" process to coordinate the waste classification with the authorities is not prescribed in either European or German waste legislation. During inspections of waste producers, disposers or waste transports, there may therefore be divergent assessments of the "correct" waste code and corresponding clarification procedures.

2.2.4 Consequences of a the classification of substances and mixtures according to chemicals legislation

2.2.4.1 Legal consequences of a classification as "hazardous" in chemicals and specific product legislation

The chemical classification and corresponding labelling are used by companies in the supply chain to communicate the hazardous properties of substances and mixtures. As soon as substances or mixtures are classified as hazardous, suppliers are obliged to provide their customers with an SDS containing both detailed information on the hazardous properties and information on safe use, e.g. at the workplace and in relation to the environment. For mixtures, all classified ingredients present in the mixture above defined concentration limits must also be identified. In addition, a product label with the most important safety information must be issued.

In addition, the classification of substances and mixtures may make certain uses not (or no longer) possible, as certain hazardous properties are excluded for certain products. Some examples are the general restrictions on the use of CMRs in chemical consumer products or the restriction of the use of CMRs in toys according to the 2nd ProdGV (implementation EU Toy Safety Directive).

A substance that is manufactured or imported in quantities of more than 10 t/a also requires the respective registrants to carry out a chemical safety assessment as part of the registration (see Chapter 1.3.5).

A comparable exposure assessment is carried out by the authorities as part of the wider risk management process. This is the case, for example, if it is suspected that the use of a substance will trigger further, previously unaddressed risks. In these cases, the risks are examined, and measures are derived to eliminate the risks or at least reduce them to an acceptable level. Within the framework of REACH, these measures are laid down EU-wide in more or less differentiated restrictions of use[37] after a decision-making process at the level of the EU Member States including public consultations (cf. Art. 67ff. REACH Regulation in conjunction with Annex XVII).

Alternatively, the authorisation procedure according to Art. 55ff. under REACH formulates a general prohibition of use with the possibility for justified exemptions.

[37] This may also lead to regulations in other frameworks, e.g. if such restrictions are to be regulated at global level within the Stockholm Convention. These substances will then not be restricted within REACH, but within the framework of the so-called POP Regulation (Regulation (EU) 2019/1021 of the European Parliament and of the Council of 20 June 2019 on persistent organic pollutants) https://eur-lex.europa.eu/legal-content/DE/ALL/?uri=CELEX:32019R1021. These regulations are similar in their prohibitions to the restrictions under REACH in many cases, but also contain additional regulations for waste containing POPs.

The authorisation requirement is a possible consequence of the identification of a substance as SVHC and its inclusion in the candidate list. A (harmonised) classification can already sufficiently justify SVHC identification in the case of CMRs.[38] Due to its status as an SVHC, a corresponding risk assumption arises immediately, which implies such a comprehensive use ban. However, it should be noted that after confirmation of the SVHC properties, inclusion on the so-called candidate list alone does not imply a ban on use. Rather, extended communication obligations on the presence of hazardous ingredients and their safe use are the consequence (cf. Title IV REACH).

2.2.4.2 Legal consequences of a classification as "hazardous" in occupational health and safety

The classification of substances and mixtures also has direct consequences for occupational safety and health (OSH). If hazardous substances are handled at the workplace, the potential risk to employees must be assessed. The legal basis for this is Section 3 of the German Ordinance on Protection against Hazardous Substances (GefStoffV). According to this, it is the responsibility of the employer to assess possible risks at the workplace and, if necessary, to introduce protective measures. Special requirements apply to employees who have a special need for protection, such as minors and pregnant women.

The handling of CMR substances also results in extended obligations to minimise worker exposure, including via substitution, or regular measurements of workplace exposures, health examinations and the compilation of a register of employees who handle such substances

Within the OSH framework, employers are also obliged to keep a register of hazardous substances, which contains the hazardous substances used in the company (i.e. also all substances classified as hazardous).

2.2.4.3 Legal consequences of a classification as "hazardous" under installation-related legislation

The classification of substances and mixtures also has a direct impact on the permitting and design of industrial installations and the resulting operator obligations.

According to the Federal Immission Control Act (BImSchG), the operation of facilities in which hazardous substances (depending on the quantities) are handled must be permitted. The handling of classified chemicals may also result in a far-reaching liability obligation should they be released from the facility and damage environmental media (§ 5 (4) BImSchG). On the other hand, SVHCs on the candidate list according to Art. 57 d-f (PBTs/vPvBs or comparable, environmentally relevant properties, such as endocrine disrupting properties) currently do not have a profound influence on the permitting and operation of installations. However, there is a requirement to minimise inputs into the environment for them, as no impact thresholds can be derived for chemicals with these properties.

As part of the permitting procedure, the potential operators of the facilities must compile information on the hazardous substances and obtain approval for the design of the facilities. In this respect, numerous regulations on the BImSchG substantiate the plant requirements depending on the respective hazardous property and in connection with the quantities used. In this context, particular requirements of the 12th Ordinance on the Implementation of the Federal Immission Control Act (Major Accidents Ordinance - 12th BImSchV) must be observed. Here, extended requirements are specified in order to avoid accidents (incidents) and to minimise their effects regarding the release of chemicals or chemical reactions. This includes, for example,

[38] Nevertheless, the SVHC identification process must be gone through.

distance regulations to residential areas, the preparation of emergency plans and the concrete design of plant components. Under certain circumstances and depending on the size of the installation, the environmental impact must also be assessed for approval (see § 18 of the 12th BImSchV in conjunction with § 8 of the Environmental Impact Assessment Act (UVPG)) and there are regular reporting obligations during operation.

For installations that do not have to be permitted in accordance with the BImSchG, obligations also apply to the handling of certain hazardous substances. These result from the Water Resources Act (WHG)[39] , which stipulates requirements for handling substances hazardous to water in § 62. The assignment of the status of a "substance hazardous to water" according to the Ordinance on Installations for the Handling of Substances Hazardous to Water (AwSV) also includes substances that have defined hazardous properties in terms of chemicals legislation.[40] Here, too, the classification according to CLP[41] has an indirect effect on the requirements for the facilities.

2.2.5 Excursus: Evaluation of the waste phase under REACH

The requirements of REACH on risk assessment are intended to ensure the safe use of chemicals along their entire life cycle. This includes - notwithstanding the separation in principle of chemicals and waste legislation (see above under 3.1) - the waste phase. The corresponding requirement exists for substances classified as "hazardous" in the following REACH processes:

- Registration: The chemical safety report shall assess the risks of all known uses or uses supported by the registrant, including their waste phase. [42]
- Authorisation: In the authorisation application, risks that may arise from the uses applied for must be assessed and documented in a chemical safety report. It is possible to refer to a chemical safety report from the registration, but practice shows that these are not detailed enough for substances subject to authorisation. The area of environmental emissions, especially the assessments of the waste phase, is usually redeveloped by the authorisation applicants.
- Restrictions: In restriction proposals, authorities must demonstrate that the presence of a substance in a use or product creates unacceptable risks that require EU-wide action. Risks that only appear in the waste phase can also justify a restriction proposal. The case of polybrominated flame retardants, which in addition to direct exposure and health effects can also be released (only) during waste treatment or carried over into new products via recycling, is an example of this.

The assessment of potential risks in the waste phase by registrants in the context of the chemical safety assessment should lead to the derivation of RMMs, as described, inter alia, in the ECHA

[39] In the case of installations permitted under the BImschG, the permit under water law is also covered and does not have to be considered separately.

[40] However, an extended system for deriving water hazard classes is established here, which is only partly based on the classifications and includes other aspects.

[41] In addition, the AwSV contains further criteria that do not directly refer to chemicals legislation.

[42] A chemical safety assessment is only mandatory for substances registered in quantities of 10 t/a or more. If safe use can only be achieved through the application of RMMs, these shall be communicated to the supply chain as binding conditions of use with the SDS, including waste treatment requirements. If, according to the assessment, safe use is not possible, a use shall not be supported (identified) by the registrant.

Guidance on Exposure Assessment in the Waste Phase[43]. These could be, among other things, indications of which products hazardous substances should not be used in due to possible risks in waste treatment, or which waste treatment processes, including the production of secondary materials, should be avoided from the viewpoint of the respective substance. This information should be included in chapter 13 of the SDS and communicated at least to the producer of an article.

According to the authors' current knowledge, the registrants have so far not implemented this fundamental obligation in practice or only in very general terms. This is why at present only very basic - and in the environmental field mostly fed by accidental release measures - indications on certain conditions of waste handling and treatment which must be observed, can be derived from the chemical safety assessments. An example of a requirement would be that liquids containing the substance and produced in the course of the intended use must not be discharged into wastewater, but rather be transferred to a regulated waste disposal system. If more differentiated risk assessments were available, they could inform the waste classification and thus possibly be used to improve the control of material flows in the waste phase. For this purpose, they would have to be included in guidance documents for waste producers and enforcement authorities in order to effectively supplement the information base for waste management actors. In addition, the risk assessments from REACH could also be used to consolidate the EWC by reviewing, adding to or deleting existing entries, if this should prove appropriate on the basis of new scientific findings.

Recent decisions in the field of authorisation applications show that authorities use this option for SVHCs and adopt concrete measures in scope of authorisation decisions for material streams and their waste phase, which lead to:

- the relevant waste fractions must in general be classified as hazardous waste, and
- such a waste fraction containing SVHCs cannot be recycled in principle and
- mandatory measures are to be implemented under the waste regime to ensure that the SVHCs contained are efficiently disposed of. [44]

An example of such an approach are the authorisation decisions on 4-(1,1,3,3-tetramethylbutyl)phenol, ethoxylated (octylphenol ethoxylate, OPE[45]): Aqueous fractions from institutions in the health sector (laboratories) are usually handed over to the public sewage system as wastewater (i.e. not waste) in accordance with the applicable legal situation. OPE was included in the candidate list as SVHC due to its endocrine effects on environmental organisms. No effect threshold can be derived for endocrine disrupting chemicals and therefore inputs into the environment are to be generally minimised. Following SVHC identification, the authorisation procedure at EU level was selected as the most appropriate regulatory measure. The authorisation decisions for OPE require that aqueous fractions containing this SVHC are mandatorily considered as hazardous waste. At this point, regulations from chemicals legislation lead to a binding substantiation of wastewater legislation (disposal as wastewater is no longer possible) and waste legislation (waste is to be disposed of as hazardous waste, although the

[43] See ECHA (2012) "Guidance on information requirements and chemical safety assessment, Chapter R.18: Exposure scenario building and environmental release estimation for the waste life stage" https://echa.europa.eu/documents/10162/13632/r18_v2_final_en.pdf/e2d1b339-f7ca-4dba-8bdc-76e25b1c668c

[44] As a rule, the objective of the efficient elimination of SVHC is laid down and less the concrete measures to be implemented for this purpose. However, this objective can often only be achieved with one "type of measure", namely the efficient collection and subsequent incineration of the fractions containing pollutants.

[45] REACH Annex XIV Entry No. 42 https://echa.europa.eu/de/authorisation-list/-/dislist/details/0b0236e1807df80d

application of Annex III of the Waste Directive would not lead to a classification as hazardous waste because the corresponding limit values are not met).

In principle, the risk assessments under REACH could be helpful for an improved management of waste streams. For example, indications can be obtained as to whether certain treatment processes for a waste enable "harmless recovery" or whether "disposal" is necessary. This could also be carried out independently of the regular waste classification process.

2.2.6 Legal consequences of a classification as "hazardous" under waste legislation

In waste treatment, the classification of waste as "hazardous" is decisive for the following aspects:

- Permitted waste operations with regard to mixing and separation,
- Necessary plant permit including associated plant design requirements e.g.
  - Sealing of storage areas
  - Various storage facilities to keep hazardous waste separate,
- Exhaust air filter technology may be necessary,
- Necessary OSH measures, e.g.
  - Preparation of risk assessments with regard to hazardous substances and derivation of suitable protective measures
  - Occupational health surveillance of personnel
  - Monitoring of pollutant limits
- Here, too, knowledge of the content of hazardous ingredients is important in order to establish appropriate risk management in the respective subsequent steps. It should be noted that the waste treatment steps can release hazardous substances from the matrices of the materials containing them (e.g. in thermal processes) or make them available on further exposure pathways (e.g. through dusts).

2.2.6.1 Mixing and separation

The classification of a waste as hazardous entails a mandatory prohibition of mixing and a duty to keep wastes separate, according to § 9a KrWG. Exceptions may be permitted:

- if this takes place in a facility that has been explicitly approved for this purpose in accordance with the BImSchG or
- if, during mixing, proper and harmless recovery can also take place and the harmful effects for human health and the environment are not increased, or
- a mixing process is state of the art.

However, these practices contradict the goals of the EU Commission's revised Waste Framework Directive (WFD)[46], according to which hazardous substances should be removed from the material cycle as much as possible. A "dilution" of fractions with different contamination levels

[46] Cf. recital 38 DIRECTIVE (EU) 2018/851 http://data.europa.eu/eli/dir/2018/851/oj

by mixing them with the aim of complying with existing limit values is not permissible in the sense of the WFD. Mixing in violation of the above-mentioned rules may result in obligations to separate hazardous waste or the obligation to treat it further at a facility authorised for this purpose (cf. 9a (3) KrWG)[47] .

Another measure that can ensure the separation of hazardous waste is the possibility of defining obligations for the provision and delivery for special types of waste pursuant to § 17 KrWG[48]. The federal states can define these obligations for hazardous waste streams in order to control undesirable environmental impacts of waste disposal.

2.2.6.2 Pre- and post-tracking (consignment note procedure)

The classification of a waste as hazardous enables waste authorities to monitor the fate of hazardous waste to ensure that it is properly treated and, if necessary, disposed of. Therefore, two elements of waste monitoring stem from the hazardous waste classification.

The so-called proof of disposal pursuant to § 50 para. 1 sentence 2 no. 1 KrWG in conjunction with §§ 3 to 9 and 17 to 22 of the Verification Ordinance (NachwV) forces the actors involved to agree on the disposal route in advance. This means that waste producers, disposal companies and the responsible authority agree on the disposal route and thus establish a prior control.

This procedure is supplemented by the follow-up procedure based on the consignment notes. It ensures monitoring of the actual whereabouts of the hazardous waste (pursuant to § 50 para. 1 sentence 2 no. 2 KrWG) by documenting (electronically) the realisation of the previously clarified disposal route based on the consignment notes. The consignment note is used to transmit the following information on the waste:

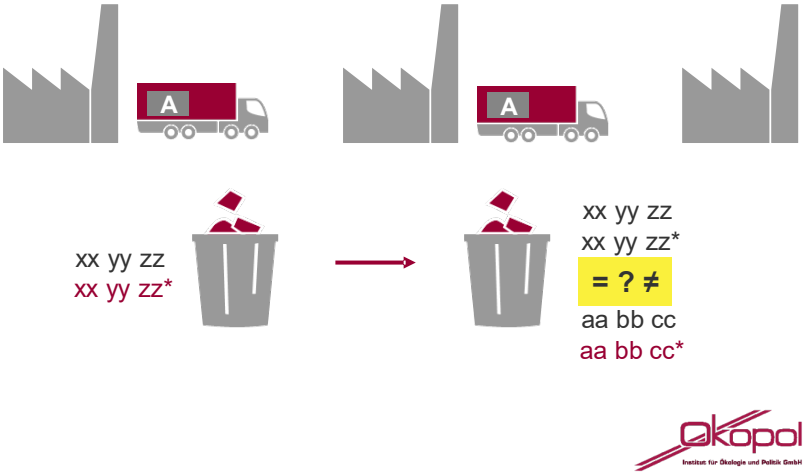
- Waste designation, waste code and quantity of waste transported in tonnes
- Proof of disposal (§ 28 Abs. 2 Satz 1 NachwV)
- Information on the waste producer (producer number, unless dispensable (e.g. small quantities), date of acceptance of the waste)
- Information on the carrier (carrier number, date of acceptance of the waste, vehicle registration number, company name, address)
- Details of the waste disposer (disposer number, company name, address).

It should be noted that a disposal route can also end with delivery to an appropriately licensed treatment facility (e.g. a sorting facility). In this case, the waste can leave this facility as waste, but may then have a different waste code (e.g. according to Chapter 19 AVV). Figure 29 shows a schematic overview of the possibilities of reclassification.

[47] Intentional mixing of hazardous waste may be necessary to comply with plant-related limit values, see e.g. §§6-8 of the 17th BImSchV. Mixing of wastes may also be necessary in physicochemical treatment plants, e.g. to precipitate heavy metals, neutralise acids or bases and destroy substances such as nitrates, nitrites or cyanides. The mixing ban essentially aims to prevent hazardous waste or waste containing POPs from being mixed with other waste or materials in order to be recycled ("dilution").

[48] Such requirements can also be issued for non-hazardous waste, but then require explicit legal regulation, as has now been done for waste containing POPs. "Ordinance on the Separate Collection and Monitoring of Non-hazardous Waste Containing Persistent Organic Pollutants (POP Waste Monitoring Ordinance)" https://www.gesetze-im-internet.de/pop-abfall-_berwv/BJNR264410017.html

Figure 29: Possible changes in the classification of waste due to recoding in the treatment chain[49]



Source: own representation, Ökopol

2.2.6.3 Occupational safety and health requirements

Operators of waste treatment plants, like all other employers, must comply with the statutory occupational safety and health provisions, including the Ordinance on Hazardous Substances. Although waste is by definition not a substance or mixture, the Ordinance applies (also) if waste contains "hazardous substances" (cf. § 8 GefstoffV). With regard to the classification of waste, the Technical Rule for Hazardous Substances (TRGS) 201 specifies that the classification rules from waste legislation are not used as a basis, but that classification and labelling rules are formulated in accordance with chemicals legislation.

When handling wastes that are to be regarded as hazardous chemical agents on the basis of an assessment in accordance with CLP, there is a particular obligation to carry out a risk assessment and, if necessary, to derive protective measures. The following hazards typical for the waste treatment industry are named in the literature of the employers' liability insurance associations[50] :

- "[...] exposure of the respiratory tract to dust (e.g. mineral dusts, quartz),
- sensitising and allergic effect on the respiratory tract or skin,
- asphyxiation due to lack of oxygen,
- harmful effects on health (e.g. of cadmium or mercury in old electrical appliances),
- fire hazards due to glow nests in dust deposits and due to other flammable substances,
- carcinogenic effect (e.g. from diesel engine emissions, polychlorinated biphenyls, asbestos),
- accidental ingestion of hazardous substances."

How the concrete knowledge of possible hazardous substances necessary for a risk assessment is obtained, especially for waste classified as non-hazardous, is not further regulated by law.

[49] After the treatment, wastes may maintain the former waste code (identification of waste origin may be possible) or be assigned a new waste code (identification of waste origin may not be possible anymore). This may also change the classification as hazardous.

[50] See BG Verkehr Verkehrswirtschaft, Post-Logistik, Telekommunikation (October 2016) DGUV Regel 114-602 Branche Abfallwirtschaft Teil II: Abfallbehandlung https://www.bg-verkehr.de/medien/medienkatalog/dguv-regeln-und-dguv-grundsaetze/dguv-regel-114-602/at_download/file

Generally, however, § 6 of the Ordinance on Hazardous Substances (GefstoffV) also obliges waste handlers to identify the substances handled at the workplace, to determine the risks associated with them and, if necessary, to implement protective measures. In addition, TRGS 201 describes a procedure for situations in which information is insufficient.

In practice, it is essentially the acceptance/handling of "hazardous waste" that "triggers" the implementation of extended OSH measures (such as measurement and monitoring programmes at the relevant workplaces).

2.2.6.4 Permitting under plant legislation depending on waste classification

For the operators of recycling plants, the link between the waste classification of the treated waste and the necessary plant permit is of high importance. Small or old recycling facilities that treat non-hazardous waste often only have a building permit in accordance with the respective local requirements.

If larger quantities of waste or waste classified as "hazardous" are treated, a permit according to BImSchG[51] is required and is integrated in the building permit. Section 4 of the BImSchG stipulates that "stationary waste disposal facilities for the storage or treatment of waste" require a permit, whereby the type of waste disposal facilities requiring a permit is specified by the 4th Federal Immission Control Ordinance (4.BImSchV).

Thereafter, a permit must always be obtained for installations for the "recovery and disposal of waste and other materials" (§ 1 of the 4th BImSchV).

A permit pursuant to BImSchG must be obtained for hazardous waste if the tonnage treated is ≥ 1 tonne/day or the storage capacity is more than 30 tonnes. If the throughput of treated hazardous waste exceeds 10 tonnes/day or the storage capacity exceeds 50 tonnes, a licensing procedure pursuant to § 10 (10) BImSchG (with public participation) must be carried out, otherwise the simplified procedure pursuant to § 19 BImSchG is sufficient.

For non-hazardous waste, facilities with a throughput of less than 10 tonnes per day or a storage capacity of less than 100 tonnes only need a permit under the simplified procedure. An exception is made for facilities that pre-treat waste for incineration (procedure with public participation from a throughput of 50 tonnes per day).

The licensing procedure under the BImSchG also includes waste licensing as defined in Part 6 KrWG, in particular those with obligations for facility operators under Section 46. For instance, municipalities may impose conditions to protect the public interest (including the environment), such as limiting the type of waste ("acceptance catalogue") that may be handled in an installation.

Changes to existing installations licensed under the BImSchG must be notified or an application for a change permit must be made (§ 16). A change can be both structural and affect the operational process, in the case of plastics recycling, the treatment of a different waste.

Changes must always be reported if they could result in changes to the objects of protection under the BImSchG (humans, animals, plants, soil, water, atmosphere, cultural and material goods). These protected goods can be affected by air pollution, odours, noise, vibrations or even waste. Thus, the following cases that could lead to a modification of an existing installation that

[51] The Act implements Directive 2010/75/EU on industrial emissions. It establishes a permit requirement for installations and stipulates that waste management activities fall within the scope of the Directive (cf. Article 4, Article 10 and Annex I).

must be reported or requires a permit are conceivable. The decisive factor is whether this change must be considered "substantial". Examples of this are:

- Throughput/storage capacity of the installation with waste increases and a quantity threshold according to 4th BImSchV Annex I is exceeded.
- The waste classification results in other Annex I categories applying to the facility.

For existing installations approved under the BImSchG, this may mean that a new application is necessary according to the approval procedures with an environmental impact assessment.

These criteria are also relevant with regard to installations previously "only" approved under building law. In this case, it must be examined whether such a change makes it necessary to submit an initial application in accordance with the BImSchG.

2.2.7 Further approaches to risk management in waste legislation

The difference in the subjects of regulation between chemicals legislation and waste legislation (cf. section 1.3.2) has consequences, among other things, for the risk considerations on which the two areas of law are based and which are therefore not completely mutually transferable Here, the risk considerations are not to be understood exclusively as a concrete, formalised process, as is the case, for example, in the context of the chemical safety assessment under REACH.

Risk considerations in waste legislation are, as understood in this presentation, also regulations (e.g. special legal ordinances, guidelines, etc.) in which authorities make further specifications for waste in order to protect people and the environment. These can be, for example, regulations that are intended to ensure the targeted supply or exclusion of a waste stream to/from certain treatment processes. Such regulations can be found, for example, in (not exhaustive):

- Waste Oil Ordinance[52] (AltölV): Here, for example, waste oils with PCB contents > 20 mg per kg of waste oil are excluded from recycling (§3 AltölV). In addition, further requirements for the handling and separation of different collection categories are formulated for waste producers and collectors. In addition, the waste codes to be used for the respective collection categories of waste oil are specified (Annex 1) and specifications are made for more detailed pollutant analyses (Annex 2).
- Ordinance on Requirements for the Recovery and Disposal of Waste Wood[53] (Waste Wood Ordinance - AltholzV): The ordinance defines different collection categories depending on the pollutants they contain (treatment with and without wood protection agents, containing halogens, with and without paints, PCBs). In addition, specifications for the examination and limit values for the content of certain substances for the individual recovery paths (material, energy recovery) are defined.
- Communication of the Federal/State Working Group on Waste (LAGA) 31B "Implementation of the Electrical and Electronic Equipment Act" and "Technical requirements for the treatment and recovery of waste electrical and electronic equipment"[54]
  The treatment requirements support waste handlers in identifying specific pollutants in

[52] Waste Oil Ordinance in the version published on 16 April 2002 (BGBl. I p. 1368), available at: https://www.gesetze-im-internet.de/alt_lv/

[53] Waste Wood Ordinance of 15 August 2002 (BGBl. I p. 3302), available at: https://www.gesetze-im-internet.de/altholzv/

[54] Both notices can be found at https://www.laga-online.de/Publikationen-50-Mitteilungen.html

electrical and electronic equipment or in components of these products. In addition, they provide specific requirements for handling the pollutants or components containing pollutants (de-pollution and further treatment).

These partly pragmatic and generic approaches in waste legislation can lead to ambiguities and inconsistencies at the interface with chemicals legislation, which raise questions among the actors involved and sometimes result in legal uncertainties.

A major difference in the classification procedure is that in waste legislation the starting point for identifying possible risks and necessary measures to avoid them is usually a less clearly defined "waste", for which the "hazardousness" is determined depending on its origin and the identity of any ingredients it may contain.

In contrast, risk assessment in chemicals legislation always begins with the identification of hazardous properties of a clearly defined substance and the identification of possible uses, including an assumption about what kind of waste a substance will be found in at the end of its life.

2.2.8 End of waste status

Both the start and the end of the waste status of products and objects are not clearly defined and in practice conflicts are frequent when it comes to clarifying "grey areas". While there is a multitude of clarifying case law and enforcement aids on the objective and subjective waste characteristics[55] i.e. the beginning of waste status, the corresponding specifications of the general regulations on the end of waste status are often missing.[56]

With regard to the end-of-waste of "hazardous waste" or waste containing hazardous substances, the issues here are somewhat more complex. In principle, material streams should only be released from the waste regime if they do not pose a risk to human health (§ 5 KrWG). At the EU level, there have been efforts to define material flow-related criteria for the end of waste. For iron, steel, aluminium scrap, glass and copper, corresponding criteria have been developed and implemented by means of EU regulations[57]. In part, national criteria exist for certain waste streams, criteria on the type of treatment to be provided and whether mechanical recycling is permissible, such as the regulations for waste wood and waste oil. For other material streams (e.g. plastics or building materials), however, such harmonised criteria are largely absent, leaving this area to the self-assessment of the waste and recycling actors[58].

This multitude of aspects leads both to considerable uncertainties for the economic activities with regard to the legal requirements that have to be met (product legislation or waste legislation?) and to the fact that possible risks for humans and the environment may not (be able to) be adequately assessed after placing recycled materials on the market (end of waste status but lack of sufficient information to comply with chemicals and product legislation). Situations may arise in which materials, after regaining product status and despite being (again) subject to

[55] 3(1) including (2-4) WFD/KrWG

[56] See § 5KrWG

[57] Regulation (EU) No 333/2011 http://data.europa.eu/eli/reg/2011/333/oj, Regulation (EU) No 1179/2012 http://data.europa.eu/eli/reg/2012/1179/oj, Regulation (EU) No 715/2013 http://data.europa.eu/eli/reg/2013/715/oj

[58] In a wide variety of projects carried out by Ökopol in cooperation with recycling plants - e.g.. e.g. "Legally secure plastics recycling under current REACH and waste legislation - Guidance and position paper based on practical operational examples" BKV GmbH, Frankfurt am Main (DE) 2016-19 as well as "Feasibility study on tools to support information flows on substances in articles along value chains and to the waste sector", DG GROWTH, Brussels (BE) 2018-20, the corresponding enquiries consistently showed the result that there were never any queries from the competent authorities in this area.

chemicals legislation, may find their way into areas of use in which they are not allowed to be used due to waste requirements.

One example of this is the use of mineral waste in soils. The waste legislation contains specifications for this, e.g. limit values for heavy metals. Within the framework of REACH, such materials (grate ashes/paper ashes[59]) have been registered on a large scale by recycling companies for use in construction activities close to the ground, among other things. The soil protection limits for waste discharge no longer apply to these materials, as they are now no longer waste. As the responsibility for registration lies with the placer on the market (producers of secondary materials), the assessment of which of the uses in soils are identified as "safe" is not initially reviewed by the authorities.

Further grey areas may arise if the so-called recycling privilege according to Article 2.7 d REACH) is applied, which foresees facilitations and specific regulations that exempt substances produced/recovered from waste from the registration obligation. The application of the recycling privilege requires proof of the "sameness"[60] of the substance with an existing registered substance. For hazardous substances (in recovered mixtures), classification and labelling and the existence of safety information (SDS) are necessary, as well as clarity that there is a "manufacture from waste" (ultimately the recycling step). If the uses of the secondary raw material differ from those of the already registered primary raw material, the downstream user must carry out an independent exposure and risk assessment for these (his) uses according to Article 37 REACH.[61] An interpretation of the requirements and guidance on their implementation was published, e.g. in UBA Text 55/2011: "REACH and the recycling of plastics - Reference manual for an appropriate implementation of the REACH requirements for the operators of recycling plants" Here, too, the legal obligations are on the side of the market actors, while official inspections (can) only be carried out on a spot check basis.

Various problems can result from the lack of clarity as to when waste status ends, e.g. in the transnational transport of recycled materials: In contrast to the transport of hazardous waste, which requires a permit even between European countries[62], the free movement of goods is possible for products. Thus, when market actors declare that a waste stream has reached the "end of waste status" and is thus legally defined as a product; this former waste stream can be freely traded or transported in the EU.

However, the rules for placing on the market outlined above and any existing labelling and communication obligations must be fulfilled. In reality, there are known cases where waste was declared as a product in accordance with chemicals legislation (and local waste authorities), but this status was challenged by other authorities and penalties were imposed for illegal waste transports.

[59] Paper ashes contain a high proportion of free lime and were therefore recycled in production. According to information from the industry, this recycling route has virtually come to a standstill, as the ashes have been subject to registration under REACH. Currently, the registration includes 77 active registrants. According to ECHA, the tonnage range of these ashes is 1,000,000 – 10,000,00 tonnes per year (cf. ECHA database https://echa.europa.eu/substance-information/-/substanceinfo/100.166.396).

[60] In this context, "sameness" is defined by the identity of a main component (content > 80% of the substance) that corresponds to a registered substance, which then allows an exemption from the registration obligation. Since the remaining 20% of the composition of the substance in extreme cases are not taken into account in the "sameness", the substances can have significant differences in the concrete composition, which can also lead to different hazardous properties and thus classifications.

[61] A recycler as a manufacturer does not have this obligation, as he is exempted from Title II and V of REACH by Article 2 7d.

[62] Following the rules of Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste, which implements the requirements of the Basel Convention.

In the two problem areas described - the use of recovered substances (in materials) in undesired or prohibited uses and the declaration of the end-of-waste or product status - a clear divergence can arise between the partly stricter rules of waste legislation and those in chemicals legislation.

A further problem area is the fact that waste materials containing higher levels of hazardous substances are not currently released from the waste regime at the mixture level, as this would mean that they would subsequently have to be classified and labelled as "hazardous" in the product area according to chemical legislation. In such cases, especially in the case of plastic waste, articles are often still manufactured within the waste phase and only then the end of waste is declared. In view of the lack of identification and labelling obligations regarding hazardous substances in articles (beyond SVHC) under REACH & CLP, important information on the inventory of hazardous substances and on risk management for the further life cycle stages (and also subsequent recycling) is missing.

In order to clarify these uncertainties, the legislator may, in accordance with §5 para. 2 KrWG and after consultation with the interested parties, issue legal ordinances that define in more detail the conditions under which the waste status of certain substances and objects ends. In this context, authorities and economic operators should develop harmonised standards containing quality nomenclature and pollutant limit values. Therefore, harmonised standards and quality norms are important tools to achieve a common understanding across authorities and among economic actors about the status of a material stream (waste/product?) and also to establish a minimum standard when a waste can reach end-of-waste. This could take into account the protective idea of waste legislation and prevent unwanted inputs of materials and substances of concern into the environment (possibility to keep materials in the waste regime - limiting the waste handler's own control).

2.3 Expert Dialogue 1 and its results

2.3.1 Framework conditions

The Expert Dialogue 1 on the topic of "Dovetailing chemicals and waste legislation: current status, complementary needs as well as challenges and possible solutions" was held as a web conference on 20 September 2021 from 09:00 to 15:00. A total of 38 people took part in this dialogue.

The dialogue was deliberately conceived as an intra-authority expert debate. It aimed at an intensive and open exchange between experts in the field of chemicals regulation on the one hand and waste regulation on the other. Representatives of all administrative levels participated, from the BMU, the higher federal authorities and the state ministries to the enforcement bodies at the level of the trade supervisory authorities and the district governments.

The schedule of the dialogue, the presentation slides as well as the discussion summary coordinated with the participants can be viewed on the project website at **https://oekopol.de/themen/ressourcen-und-kreislaufwirtschaft/fachdialoge-abfallrecht-chemikalienrecht/.**

2.3.2 Selected discussion points

The following is a thematic summary of some key points from the discussions at the dialogue workshop.

2.3.2.1 Topic: Chemical classification

In the course of the discussions, it became very clear once again that a harmonised classification of substances under chemicals legislation is derived and determined exclusively on the basis of scientific data on the respective substance properties. It was emphasised that the downstream legal consequences in chemicals legislation or in other areas of legislation are explicitly not to be taken into account in the classification of substances and mixtures.

On the other hand, it was noted that the sometimes very significantly divergent self-classifications of substances with the same CAS number - submitted to ECHA's Classification and Labelling Inventory by various registrants and in particular also the other actors obliged to notify - are a challenge for many economic operators when carrying out hazard assessments, other risk assessments and deriving their own RMMs.

2.3.2.2 Topic: Waste classification

In the course of the discussion, the following hurdles in the interaction of chemicals and waste legislation were raised:

- Changes in the classification of substances under chemicals legislation can have a direct impact on the classification of a waste as "hazardous". The resulting legal consequences can be associated with significant economic and practical burdens for waste actors.
- Especially in the case of products (articles) with a long service life, information on proper disposal or recycling (in the product use phase) can be lost. In addition, the chemical classifications of ingredients and thus also the waste classifications can change during this period.
- According to current waste legislation (§5 (1) Nr 4 KrWG), substances or mixtures must not have any harmful effects on humans or the environment after they cease to be waste. Due to the insufficient information on the composition of post-consumer waste, recycling companies face considerable uncertainties regarding secondary products and materials.
- The possibilities to influence the design of products from the waste sector in order to prevent problems later on during their disposal have been very limited so far.
- The possibilities of influencing the design of products from the waste sector in order to prevent problems later when they are disposed of have so far been very limited.

2.3.2.3 Topic: Practice of waste classification

In the discussion, a need for action with regard to a change in waste classification became clear; in particular, it is recommended to revise the List of Waste, which is considered outdated, as well as the application of test methods for waste. However, it was critically noted that the corresponding processes are only progressing very slowly. Since only an update of the AVV in Germany was not considered expedient or possible and an update of the EWC at EU level was not to be expected in the near future, transitional solutions would have to be developed to deal with the currently existing legal basis of the List of Waste.

The possibility of testing waste to verify HP criteria 4-8 as well as HP 10-14 (Annex III WFD) was criticised. The test methods to be used according to Regulation (EC) No 440/2008 defining test methods under REACH were originally developed for the assessment of individual substances (chemicals sector). Therefore, they were not practicable for the testing and assessment of

articles or waste, among other things because various factors, such as the test medium and other boundary conditions (such as homogenisation, etc.) were not relevant or applicable.

For HP criterion 14 "ecotoxic", bioassays can also be used. Criticism was voiced in particular to the effect that according to current EU legislation[63] the results of the bio-tests can "override" the classification procedure based on the analysis results and subsequent calculation. Thus, under certain circumstances, a waste classified as hazardous according to the calculation method can be declared as non-hazardous by bio-testing. Therefore, it is critically questioned whether the validity of such tests is sufficiently verified by independent tests. The participating experts therefore considered their use to be (currently) only appropriate to a limited extent.

The idea of examining uniform classifications for entire groups of waste materials in the waste sector, analogous to the chemicals sector (e.g. substance grouping by ECHA), was also touched upon very briefly. This would reduce the complexity of the classification process and harmonise waste classifications to a greater extent. However, this aspect could not be explored further.

2.3.2.4 Overarching assessments of waste classification

Even if the waste classification is not legally intended for this purpose, in practice it still "factually" influences risk management decisions in the treatment chain. For example, the mirror entry "hazardous" "triggers" the degree of detail of workplace analyses or decisions in the selection of input materials for recycling processes, etc. for waste treaters/recyclers.

Although chemicals and waste legislation are conceptually linked in waste classification, in practice the AVV assigns a waste code in many areas exclusively based on the waste origin (absolute) and not on the material composition. This clearly puts into perspective the "theoretical" problem that is sometimes claimed to arise for the waste actors due to the dynamics of the classifications in the chemicals sector.

According to the AVV, in the case of mirror entries, the exceeding of a single HP of Annex III of the WFD is sufficient for classification as hazardous. A further examination with regard to the identification of the complete hazard profile is not required here. This purely dual character of waste characterisation (hazardous or non-hazardous) fits only to a limited extent with the complexity of the risk assessment established in other areas.

For example, the waste classification cannot meet the information needs at the end of waste in any way. In order to meet the requirements of REACH and/or relevant product regulations that apply to recycled products put back on the market, much more differentiated information on the content of substances classified as "hazardous" and other material characteristics would be necessary.

From the point of view of the participants, the establishment of a differentiated approach for dealing with the complex material information is a central prerequisite for a functioning circular economy.

It is also suggested that the waste phase risk assessments in the registration dossier should be more mandatory for registrants under REACH, as they would be helpful for enforcement in the waste sector.

[63] Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Directive 91/689/EEC on hazardous waste (2000/532/EC). Last consolidated version 01.05.2015 http://data.europa.eu/eli/dec/2000/532/2015-06-01.

3 Expert Dialogue 2 - Information flow on substances of concern at the interfaces of chemicals and waste legislation

3.1 Main topic

In order for market actors to be able to assess which RMMs risk management measures are appropriate along the entire life cycle of products, they need information on substances with hazardous properties contained therein. In particular, knowledge of the identity and concentration of substances harmful to the environment and health in products and the resulting waste is a fundamental prerequisite for this.

Within the primary supply chains, there are both legally binding requirements for information disclosure and a number of additional contractual regulations and instruments that are implemented in business practice. Also within the waste phase, there is an established system of information sharing between the different stakeholders for waste classified as "hazardous".

A key challenge for waste management actors is that, to date, information on the content of substances of concern in articles that become waste after use is systematically missing. On the one hand, the lack of substance information makes it difficult to identify and implement specific and adapted risk management measures. In addition, such substance information is also needed in order to be able to produce targeted (safe) secondary materials with the help of appropriately "informed" sorting and treatment decisions that meet the quality requirements of the product manufacturers for reuse in the production area and subsequent further use phases.

3.2 Expert background on the flow of information on substances with hazardous properties

3.2.1 Existing information obligations

With regard to the flow of information from the supply chains to the actors of the waste phase, it should be noted that "waste" - and thus de facto also the waste phase - is explicitly excluded from the scope of REACH in the sense of the WFD[64] according to Article 2 (2) REACH. This means that while information on communication is (or can be) identified in the context of the chemical safety assessment, there is neither a mechanism for communicating it to the waste actors nor an obligation laid down in REACH for communication on substances of concern in the waste treatment chain.

Furthermore, the fundamental differences in the "objects" to which the legal requirements for communication in chemicals legislation or waste legislation refer are relevant for the flow of information on substances of concern.

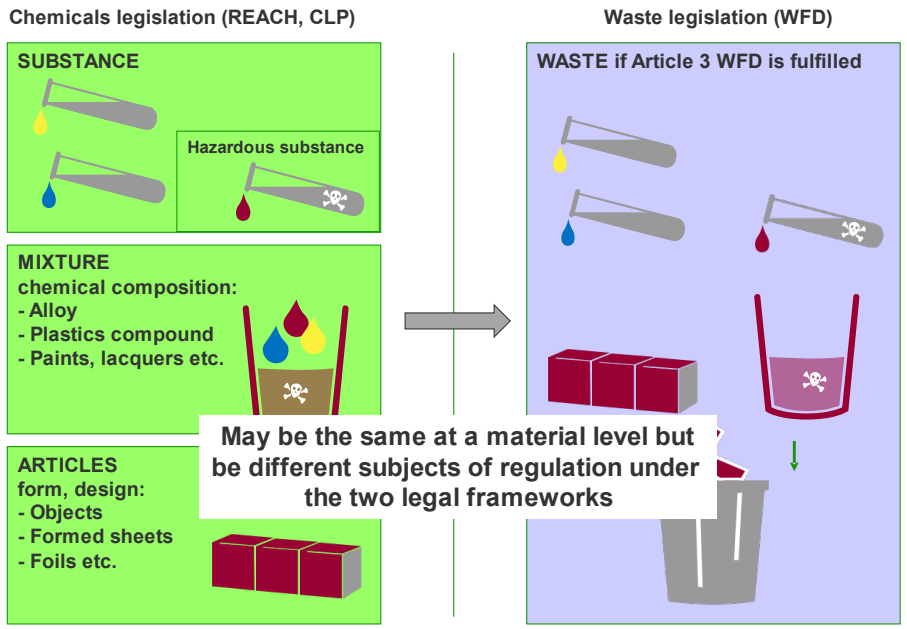
Both for the determination of the hazard and for the dissemination of information on the content of classified substances, very different requirements apply in chemicals legislation, depending on whether the "object" of the regulation is a substance, a mixture or an article. Substances, mixtures and articles are clearly defined and demarcated from each other by law.

[64] Directive 2006/12/EC of the European Parliament and of the Council

In contrast, waste legislation only recognises waste as such, as defined in accordance with the requirements of Article 3 WFD. This applies regardless of the respective physical or chemical manifestation (Figure 30, right).

The named distinctions have already been explained at the beginning (section 1.3.1), but a graphical overview is given below.

Figure 30: Fundamentally different concepts and terms between waste and chemical regulation



Source: own representation, Ökopol

For substances and mixtures, chemicals legislation clearly regulates the flow of information along the ("primary") supply chains. If the substance or mixture supplied to a customer meets certain requirements, then the downstream user (customer) must always be provided with a safety data sheet (cf. Art. 31, (3) b) REACH).[65]

These requirements are:

- A substance or mixture fulfils at least one criterion for a hazard class of the CLP Regulation and shall therefore be classified and/or
- A substance fulfils the PBT/vPvB criteria according to Annex XIII REACH (cf. Art. 31, (1) b) REACH) and/or
- A substance is listed as SVHC in the REACH Candidate List (cf. Art. 31, (1) c) REACH) and/or
- A mixture contains a substance in concentrations above 0.1% by weight that fulfils the criteria of a PBT/vPvB substance (this substance does not necessarily have to, but may have been included in the candidate list).

The information in the SDS is intended to support the safe use of the chemicals in the subsequent production processes as well as the proper disposal of any production waste by

[65] Both the classification of mixtures and the information obligations in the SDS associated with classified mixtures are limited (in each case) by concentration thresholds for the individual substances contained. The CLP Regulation also contains obligations for communication on ingredients, their hazards and protective measures. However, this will not be dealt with in depth in the following but the focus will be on the (more content-rich) communication with the SDS according to REACH Annex II.

specifying possible waste codes and disposal instructions. Accordingly, they contain, for example, information on the selection of suitable protective equipment, on ventilation at the workplace or on the limitation of emissions into the environment. The basic information on substance properties, effect thresholds or workplace limit values can be used for risk assessments of workplaces or the selection of (technical) measures to reduce emissions.

Safety data sheets can also be used as a source of information when substances or mixtures become waste. On the one hand, the chemical classification according to CLP can be used for the classification of waste ("hazardous waste" versus "non-hazardous waste"). On the other hand, chapter 13 of the SDS should contain concrete information on disposal or safe handling in the waste phase. If a chemical safety assessment has been carried out for registration, the derived information on the safe disposal of a substance must be provided in the SDS (REACH Annex II, Chapter 13). However, this procedure is currently not established in practice. In fact, the SDS, therefore, only contains cursory information on possible waste codes or only the general information that the waste must be disposed of in accordance with locally applicable legal requirements.

The flow of information with the help of SDSs ends when articles are manufactured from the substances or mixtures. Articles are defined as objects where shape, surface or design determines the function more than the chemical composition. Legally, "from here on" the obligation to communicate to downstream users is limited to SVHC of the candidate list.

According to Article 33(1) REACH, the supplier of an article shall provide his customers with information on SVHCs on the candidate list[66] which are present in the article in concentrations above 0.1% by weight. At least the identity of the SVHC has to be provided as well as the information available to the supplier of the article on the safe use of the article.

In practice, information on safe use has hardly been communicated up to now. In the past, there have been various discussions on whether information on "safe" disposal must also be communicated as "information on safe use", but without a clear outcome[67] .

In fact, the purchaser only receives the information that an article contains an SVHC in concentrations > 0.1% instead of the actually necessary list of SVHCs present including their amounts in the article or the respective concentration. He receives the more detailed information for neither the individual (partial) article nor for the entire product/device. This is especially relevant for waste management because a common consumer product such as a toaster already consists of hundreds of individual articles and even a very simple "economy peeler" is already composed of 5-10 articles.

Consumers have the right to information on SVHCs present in articles according to Article 33(2) REACH. Upon a specific request, actors in the supply chain of articles must provide the name of the SVHC(s) they contain and, if applicable, information on safe use within 45 days and free of charge if the concentration of an SVHC in the article exceeds 0.1% by weight.

The suppliers are free to choose the way they pass on information about SVHCs in articles, both in terms of supply chain communication and to consumers. In practice, this ranges from informal

[66] List of substances under consideration for authorisation (candidate list), available at https://echa.europa.eu/de/candidate-list-table.

[67] In ECHA (2017): Guidance on Requirements for Substances in Articles it states (Chapter 3.4.1 on p. 59): When identifying his information requirements "[...] the supplier of an article must consider all life cycle stages during the use of the article. [...] Furthermore, the supplier should consider the recycling and disposal of the articles [...].

information, "safety data sheets" or references in "technical data sheets" to solutions where the information is provided on the companies' websites.

If substances are newly added in the candidate list as SVHC, the two information obligations explained above apply with immediate effect, but not retroactively[68].

There are no information requirements in REACH or CLP on substances in articles that are not SVHCs.

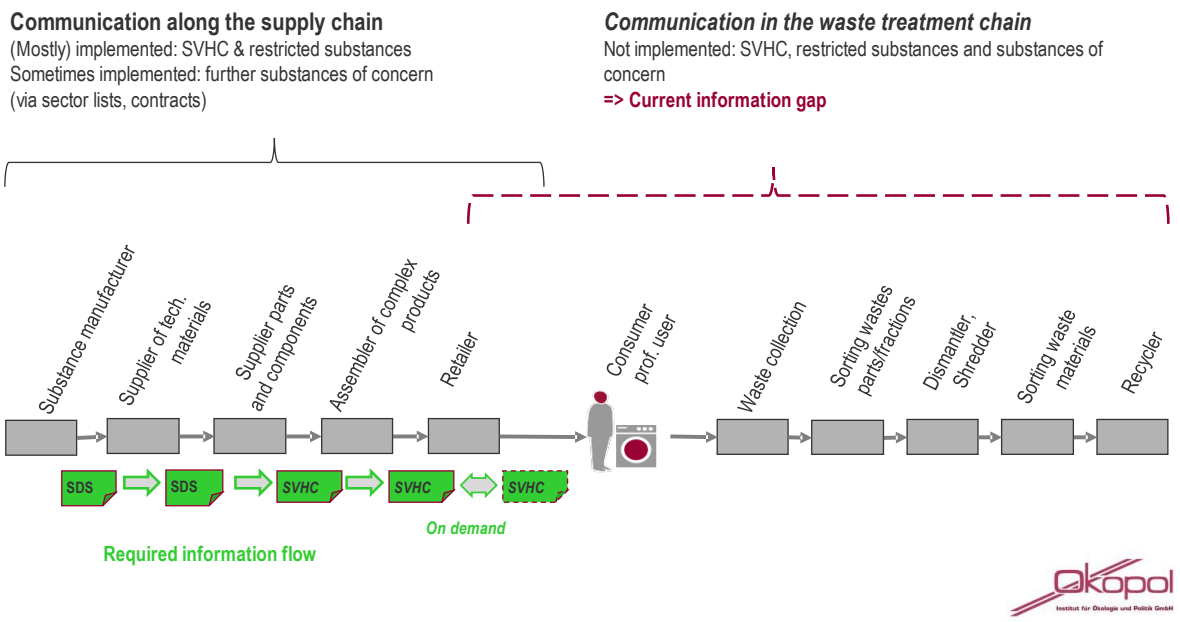
3.2.2 The information gap between production phase and waste phase

The above shows that the "comprehensive" communication on classified substances and SVHCs by means of SDSs under REACH ends with the manufacture of articles. Furthermore, it becomes clear that the more extensive communication on the presence of SVHCs in articles above 0.1 wt.% has a very limited information content. Furthermore, the information flow ends at the service life phase and does not extend into the waste phase.

The resulting "information gap" on substances of concern in articles and the waste streams generated after the article service life is graphically illustrated in Figure 31.

In the left part of Figure 31 the legally required communication on substances (in mixtures) along the value chain is shown, which for SVHCs in articles reaches up to the use phase. On the right side of the figure, it is shown that an information flow to the actors of the waste treatment chain is not mandatory.

Figure 31: Current situation of mandatory information requirements on substances of concern in articles



Source: own representation, Ökopol

The lack of an obligation to communicate substances of concern in articles that become waste[69] to waste management actors was only addressed by the new database on Substances of Concern

[68] This means that for articles supplied in the past no information on the newly included SVHCs has to be "subsequently supplied". However, if articles with the newly included SVHC are supplied again, the information on the SVHC content as well as the safe use must be updated accordingly.

[69] Abbreviated also to "product waste" as distinct from "production waste".

In Products (SCIP) provided for in 2018 as part of the amendment to the WFD. The legal basis of the SCIP database is Article 9 (2) in conjunction with Article 9 (1) lit. i of the revised WFD[70]: Article 9 (2) obliges ECHA to establish a database to which companies in the supply chain of articles have to feed information on SVHCs contained in their products in concentrations above 0.1 wt.% as of January 2021. The database must be accessible to both waste treatment facilities and the general public.

At the beginning of 2020, a first prototype of the SCIP database was published so that companies could test the intended functionalities. Since October 2020 it is possible to report information on SVHCs in articles to the SCIP database[71]. The database is structured according to the article definition of Article 3(3) REACH. This means that the content of SVHCs has to be checked in relation to the individual (sub-)articles in complex products and only exceedances of the threshold value of 0.1 wt.% have to be reported accordingly, but not the actual mass fraction contained. The SCIP database provides a system for the identification of materials and articles which enables a linkage of entries from different companies in a supply chain.

In contrast to the detailed technical functionalities for feeding SVHC information into the SCIP database, there is a lack of possibilities for waste sector actors to extract information in a form and aggregation that is helpful for their processes. The three case studies published by ECHA describe ways in which SVHC information could be used by actors in the waste sector. They still seem very abstract and difficult to implement in practice. An evaluation of the data, e.g. by summary queries of all devices of a product or collection group or similar, is possible by means of the search function, but is very time-consuming.[72]

The SCIP database currently does not (yet) provide the possibility for actors in the supply chain to voluntarily feed in additional data, e.g. further information on the real quantity content of SVHCs in the respective articles or information on regulated non-SVHC substances[73].

The SCIP database can reduce the "information gap" from the primary supply chain to the waste treatment actors (Figure 32 right), but not really close it. The mandatory information flow remains limited to the comparatively small number of SVHCs on the candidate list and it does not contain the quantity or concentration information that is often important for the decisions of the waste actors. Unlike in the primary supply chain (Figure 32 left); the information must be actively "obtained" in each case. It is only relevant for those treatment steps where the waste object is still intact, i.e. where the identity of the product (or its components) can be determined unequivocally.

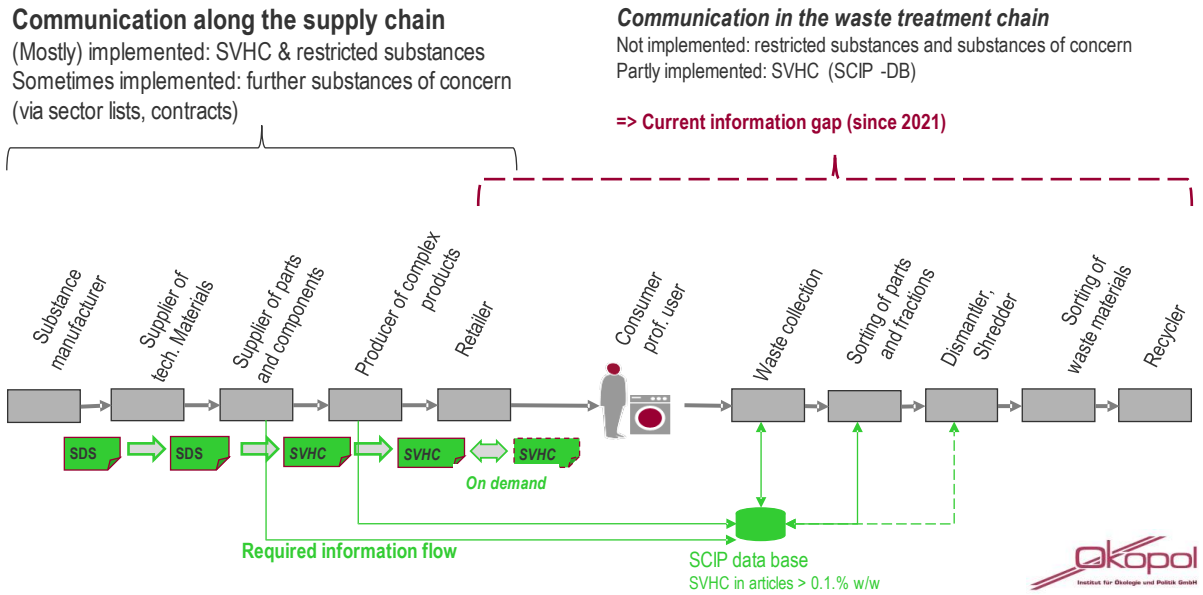
[70] more precisely, the Waste Framework Directive as amended by Directive (EU) 2018/8851 of 30 May 2018.

[71] Cf. https://echa. europa.eu/en/scip

[72] http://www.echa.europa.eu/de/waste-operators

[73] For example, harmonised substances that are subject to a restriction but have not (yet) been identified as SVHC or that do not have SVHC properties.

Figure 32: Mandatory information requirements after introduction of the SCIP database



Source: own representation, Ökopol

After the complete introduction of the SCIP database there will be a basic possibility for the actors of waste management to request information on whether an SVHC is contained in the individual articles in concentrations above 0.1 wt. %. The representation of the information gap symbolised by the red brackets in the figure was nevertheless deliberately not changed by the authors of this report compared to the previous situation. This is based on the assessment that the information from the SCIP database will only be of very limited use for the majority of substance-related decision-making needs in waste and recycling management.[74] This assessment is further elaborated in the section 3.2.3.2.

The picture of the existing information gap changes only slightly even if the information obligations and routines established in individual sectors through the extended product responsibility established by waste policies are also considered.

For example, the End-of-Life Vehicles (ELV) Directive defines a requirement for car manufacturers to provide information to dismantling facilities on certain hazardous components that are to be separated according to Annex I of the ELV Directive. This information obligation has been fulfilled in the automotive industry by means of the "International Dismantling Information System" (IDIS)[75]. Here, for each of the more than 3,000 vehicle models, lists and/or construction plans are made available that indicate the parts that have to be removed (e.g. car battery) and the mixtures that have to be separated (e.g. hydraulic oils) in accordance with the ELV Directive. Information on pollutants not mentioned in the ELV Directive (e.g. POPs such as polybrominated diphenyl ethers (PBDE)) is not recorded in IDIS. IDIS also contains hardly any substance-specific information and is not linked to the International Material Data System

[74] This assessment is based on the systematic analyses of the information needs of the different waste management core processes as well as a large number of interviews with experts to develop case studies, which were carried out in the context of a study on the information flow on substances of concern for the EU Commission ("InfoFlow study"). However, there is one important exception: SCIP data are collected for all consumer products, including technical goods, which in the sense of REACH are to be described as complex objects composed of a multitude of individual articles. This SVHC information is then available in a level of detail and structure that is excellently suited to support the legally compliant "re-marketing" of articles after preparation for reuse. This is because the actors placing the product on the market again, like the primary producers, must make the information on the respective SVHC inventory available to their customers upon request.

[75] Cf. https://www.idis2.com/

(IMDS)[76] of the automotive industry. The automotive industry has so far rejected the use of the system for the purpose of information on substances of concern with regard to waste management[77].

The Directive on waste electrical and electronic equipment (WEEE Directive) requires producers to provide information on, inter alia, preparation for re-use, recycling and treatment of end-of-life products free of charge for each new product placed on the market. This information may also concern the presence of hazardous substances and mixtures in this equipment. Industry associations provide information in line with this obligation through the Information for Recyclers Platform (I4R).[78] This database, which supports companies that treat or recycle WEEE, provides indicative information for different groups of appliances (hoovers, toasters, etc.), including information on possible pollutants in certain components. However, neither quantitative, substance-related information[79] nor concrete, appliance-specific information can be found here. This type of information for larger product groups is therefore not comparable with the detailed information on individual substances provided in, e.g. the SCIP database.

With regard to the "size" of the (still) existing "communication gap", however, not only the "type" of substances of concern is relevant, but also the waste type/origin. Basically, the following two situations can and must be distinguished here:

- **Waste fractions result from the direct use of substances and mixtures classified under chemicals legislation and labelled accordingly.**
  This is typically the case with production waste, where, for example, processing aids or other input materials become waste as a result of the process. Here, information on the type and concentration ranges[80] of the classified constituents of the initial mixtures is available to the waste producer in the SDSs[81]. The information from the SDSs can and is usually passed on to the waste disposal companies or used in agreement with them to classify the waste mixture properly as hazardous or non-hazardous (see chapter 2.2.2).

- **Waste fractions consist of products (articles) that have become waste after their "intended use" has ended.**
  As described above, the flow of information is interrupted in this case, as the obligations to pass on information for products are limited. Furthermore, for products with a long lifetime, the availability of information may also be reduced. In addition, consumers (but also most commercial users of articles) do not usually dispose of their products by handing them over to a waste management company. Instead, they dispose of the end-of-life products in a

[76] The IMDS is a database and communication system of the automotive industry. The car manufacturers contractually oblige their supplier industries to feed information about the composition of the mixtures and components used into the IMDS. A maximum of 10 % of the respective ingredients may be kept secret if they are not included in the list of substances to be declared. The data are transmitted electronically. Within the IMDS, information on individual components of a car can be linked. Confidentiality is taken into account by granting different rights to the users. Further information on the IMDS can be found here: https://public.mdsystem.com/de/web/imds-public-pages/home

[77] Within the framework of the project for the EU Commission on tools to support SVHC communication in articles, corresponding discussions were held. The contractual conditions of IMDS, which also aim at safeguarding trade secrets, show that a linkage of the two databases was and is not intended.

[78] Cf. also https://i4r-platform.eu/

[79] In the sense of "average content of substance x in assembly y".

[80] In order to protect business secrets, the safety data sheets do not indicate the exact contents, but only the concentration ranges in which the substances are contained.

[81] However, no information is available on substances that are generated in these processes or that can be generated by reactions in the (stored) waste.

collection container, e.g. for mixed household waste (or household-like commercial waste) or via the collection systems for separately collected fractions[82].

Logically, there is a third situation, namely that of production waste resulting from the processing of (semi-finished) articles, e.g. in the context of machining. Depending on the nature of the (contractual) relationship with the supplier and the extent of the information made available on the composition of the raw materials about (concerning) ingredients of the further processed articles, the situation of the waste producer can be assigned either to the one (sufficient information) or the other (hardly any/no information) of the basic situations outlined above.

A comparison of the outlined information gap with the current activities to close it is shown in the following picture:

1. In various product sectors, so-called "material compliance tools" are used to improve material-related communication within the supply chains. Some examples are BOMCheck, CDX or MDS Web.[83] What all these activities have in common is that they practically always (only) refer to the "regulated substances" in the respective product segment at the time and to those for which regulation is concretely foreseeable.
2. There are some proactive activities, e.g. the project "LIFE AskREACH"[84] and the initiative of some companies "Proactive Alliance"[85], which aim at providing SVHC information for (complex) articles on a voluntary basis up to the end customers. In the case of the Proactive Alliance this also goes beyond SVHCs[86]. These activities increase the awareness of the problem among economic operators and increase the substitution pressure for SVHCs on the market.
3. There are a few industry activities to provide so-called recycling passports or comparable information for the waste management industry. In addition to the manufacturers of medical imaging equipment, who became active at a very early stage, the I4R platform, which is supported by the European Household Appliances Association "APPLIA", Digital Europe and the WEEE Forum (see above), should be mentioned in particular. The European carpet manufacturers in cooperation with the GUT label[87] are also currently creating a system with their PRODIS database, which is intended to improve the recycling of textile floor coverings by providing information on the pollutant content.

The following figure schematically shows the points in the life cycle at which the above-mentioned voluntary (sector) activities start. The tools to ensure legal compliance support the flow of information in the primary supply chain (left part of the figure, blue). Tools to support transparency on substance content in products for trade and end customers are marked in

[82] Even with such separately collected fractions, e.g. of the WEEE collection, from the perspective of the material inventory for a specific type of appliance, it is still a matter of incredibly heterogeneous mixed fractions, since even different but functionally identical appliances from one manufacturer (e.g. different hoovers from the same company) differ significantly in their material composition.

[83] An overview of (IT) tools for communication on substances in articles can be found in the report: EU Commission (2017): Scientific and technical support for collecting information on and reviewing available tools to track hazardous substances in articles with a view to improve the implementation and enforcement of Article 33 of REACH. Final report; available at https://op.europa.eu/de/publication-detail/-/publication/58f951af-809b-11e7-b5c6-01aa75ed71a1

[84] Cf. https://www.askreach.eu/

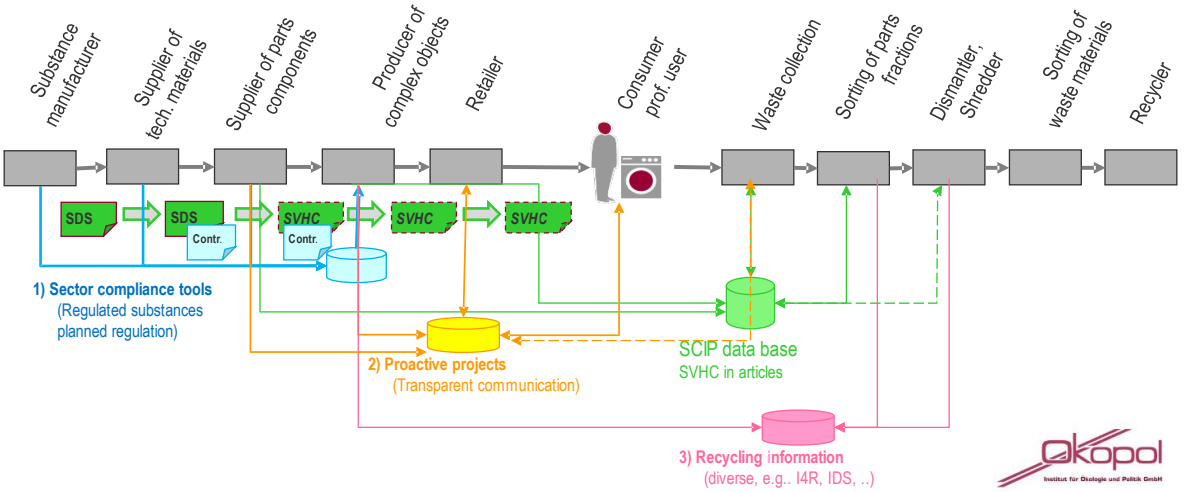
[85] https://www.proactive-alliance.info/mission-goals

[86] In many cases, the aim is to make the information on the presence of all substances on the so-called SIN list (cf. https://chemsec.org/business-tool/sin-list/) in articles accessible.

[87] Label of the Gemeinschaft umweltfreundlicher Teppichboden e.V. (Association for Environmentally Friendly Carpeting). https://gut-prodis.eu/

yellow in the figure. The databases for providing recycling information bridge the use phase of products and thus reduce the information gap to the actors collecting and (pre-)sorting/treating product waste from the respective sectors (pink, right side of the figure).

Figure 33: Voluntary activities to improve substance-related information sharing in supply chains



Source: own representation, Ökopol

This overview, which is only sketchy here, shows that the voluntary and "supplementary" activities contribute to an improvement of the substance-related information situation in the supply chains and for consumers. However, they do not systematically close the communication gap in the waste management sector.

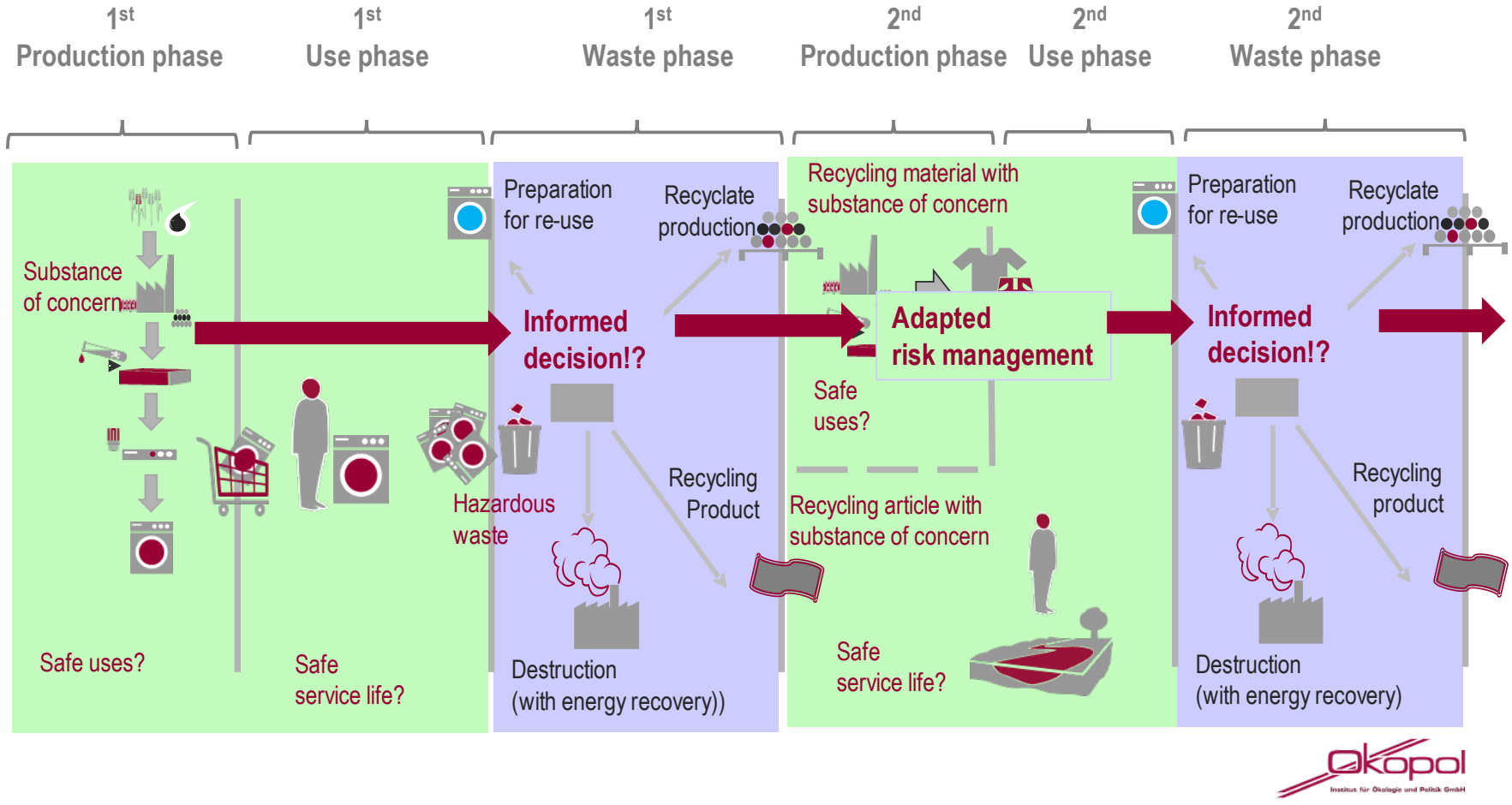
A higher transparency about the content of substances of concern in articles can, among other things, lead to an increase in demand for SVHC-free products and thus to a faster substitution of SVHCs. This would prospectively remove SVHCs from the material flows and thus reduce the need for the producer/placer on the market of the specific article to communicate accordingly. However, if new articles or articles already placed on the market are used "despite" their SVHC content, the information gaps remain relevant.

3.2.3 Functions of substance-related information on "hazardous substances" along the life cycle

After having presented databases and other sources of potentially useful substance information in the previous section, this chapter turns again to the fundamental questions "Who needs substance information?" and "What (kind of) substance information is needed?

The graph below again clearly shows that information on substances with hazardous properties is needed recurrently for informed risk management even after the initial production and use phase.

Figure 34: Recurring importance of substance information for risk management at the different life cycle stages



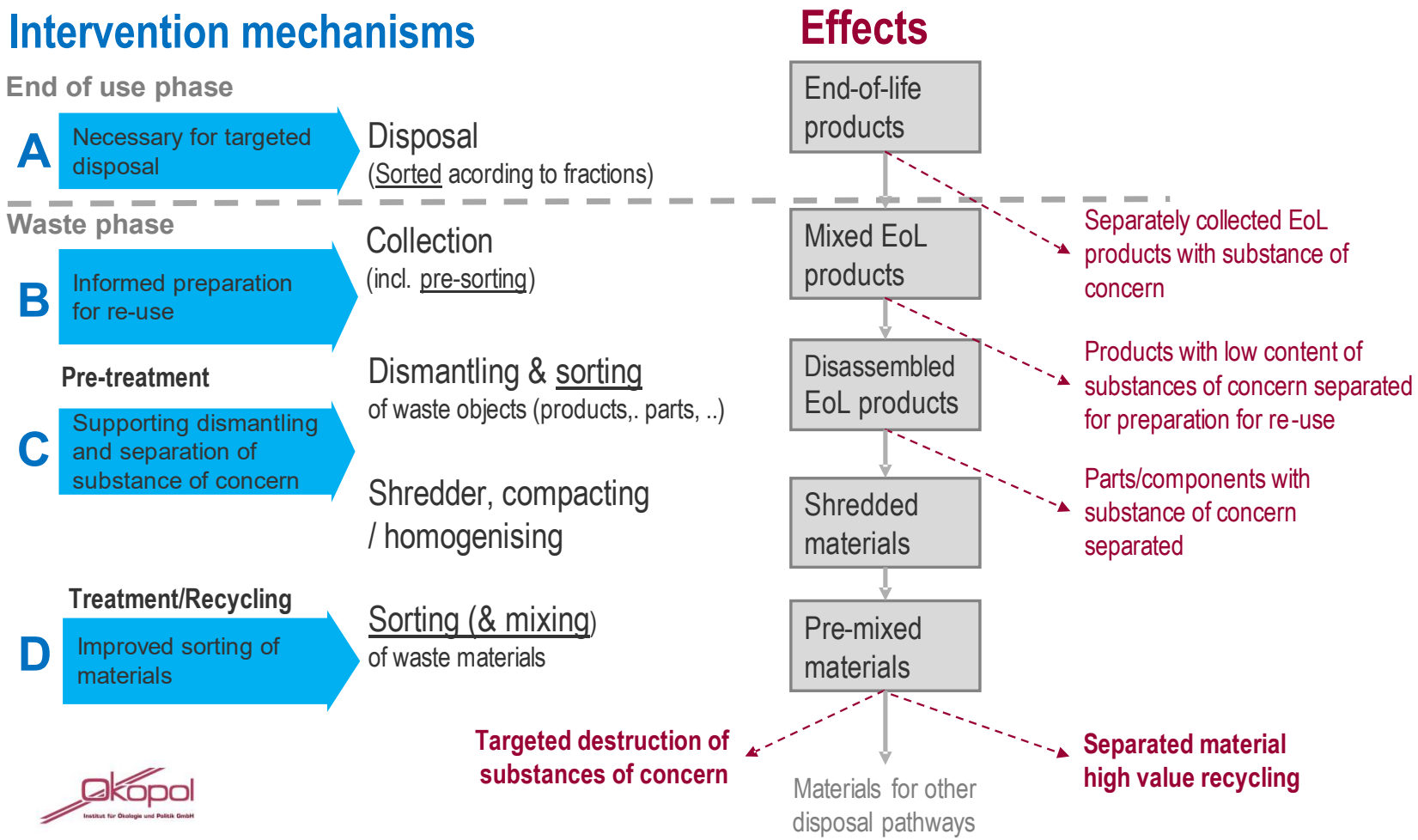
Source: own representation, Ökopol

The InfoFlow study showed that additional information on substances of concern in articles can bring about changes in the results of waste treatment and recycling, especially when it becomes available for the various sorting steps in the waste management treatment chains.

3.2.3.1 Addressees of substance information - information needs of waste management sorting processes

From the multitude of waste stream-specific treatment processes, four basic intervention mechanisms can be identified across the board as to how "informed sorting" at the different stages of the waste treatment chain could increase the quantities of materials in the cycle and improve their material qualities. The following figure shows an overview of these four basic mechanisms.

Figure 35: Intervention mechanisms for improved cycle management based on additional substance information



Source: own representation, Ökopol

These four mechanisms are outlined below:

- **Mechanism A** is based on the fact that end-of-life products are already (pre-) sorted before they become waste and are accordingly targeted for disposal. In particular, commercial actors in the field of deconstruction and/or renovation could very efficiently distinguish between problematic components or materials and rather unproblematic fractions on the basis of the information made available. In the case of plastics from the construction sector, recycling rates could be increased in this way.[88] The same applies, e.g. to the separate collection of different waste paper fractions directly at the point of origin.
- **Mechanism B** describes how the selection of products for preparation for reuse can be supported: For recycling centers or private collection points, products could simply be marked to indicate whether or not detailed information on hazardous substances is available for the respective product. For the selection of product waste for preparation for reuse, it is only important to know that this information is available. In the further course of the preparation for reuse, the detailed data would then have to be used to identify relevant substances and, if necessary, to be able to exchange individual components[89] or to implement the communication obligation on SVHCs in articles[90]. This mechanism could be relevant, e.g. for electronic products or furniture.
- **Mechanism C** addresses sorting steps in dismantling plants, e.g. for used electrical appliances, as well as the sorting of small articles as a whole, e.g. textiles. Quickly available information on the content of substances of concern in the (component) articles could support a targeted separation of corresponding objects and thus accordingly disburden the material flows that are fed into further recycling.
- The last **mechanism D** aims to support the sorting of the resulting materials after the initial treatment processes (e.g. shredding). Additional material information can support both sorting and the targeted blending of material flows from different areas of origin, which is sometimes necessary for technical reasons, and thus lead to better defined input fractions into the actual material recycling processes. This mechanism is relevant for plastics recycling, for example.

3.2.3.2 Information needs of stakeholders in the waste phase

Most actors in the waste sector assess the market potential for materials that are better sorted/defined in terms of the content of substances of concern as insufficient to justify investments in further differentiated sorting technologies. Even for waste fractions with legally defined recovery/recycling quotas, there are no qualitative specifications for the materials to be recycled that require the removal of substances of concern beyond individual legally regulated substances/substance groups. Therefore, there is currently a lack of clearly and systematically structured requirements from waste management practice for the availability of substance information for the respective waste streams.

For the discussion on how a meaningful flow of information on substances of concern in products could be established for the waste sector, it is therefore necessary to "construct" the

[88] In the InfoFlow study, this was demonstrated and discussed for the areas of composite thermal insulation boards, some of which are contaminated with hexachlorocyclododecane (HBCD), as well as the carpet qualities that can be recycled to varying degrees.

[89] To take into account, among other things, corresponding "newer" substance restrictions.

[90] At this point, as already outlined above, the information in the SCIP database could also be helpful if corresponding updating obligations are established there and the possibility of adding other regulated substances in the respective products is created. This mechanism was worked on in the InfoFlow study using the example of car and furniture components.

need for information from the fundamental objectives of waste management and the corresponding desirable adaptations of the various treatment processes.

Beyond the basic goals of the circular economy, the content and form of a possible information transfer are derived in particular from the type of (sorting) processes that are to be informed. In the following, some typical conditions and procedures of the sorting processes for the four basic mechanisms distinguished above are presented for illustration:

- Separate manual feeding of end-of-life products/materials to collection containers, which are either sent for recycling or must be specially treated because they are particularly problematic, e.g. due to the content of POPs (cf. mechanism A).
- Case-by-case assessment of products with regard to their suitability for re-use, i.e. whether sufficient information on hazardous substances is available to ensure that the products are assembled in compliance with the law and that possible information obligations on SVHC content can be fulfilled. Only in the further course of a preparation for re-use is the concrete substance information (SVHCs or regulated substances) in individual components/assemblies needed (cf. mechanism B).
- Sorting out waste as a whole or specific components that are either particularly suitable or unacceptable for a specific recycling path, e.g. during manual dismantling or in (partially) automated sorting facilities (cf. mechanism C).
- Automated detection and separation of problematic materials from the (fast-moving) input stream for recycling plants (cf. mechanism D).

In the current waste management structures, it is only necessary to support simple, mostly "binary" decisions for the sorting processes. For example, it would be sufficient if a construction worker could easily check whether a polystyrene insulation board should be disposed of in the container for EPS[91] recycling or in the other container, the contents of which will be sent for thermal disposal due to the content of HBCD or other brominated flame retardants. Another example is (pre-) treatment plants of small electrical appliances, which "only" need to know whether a device contains a lithium-ion battery or not. This knowledge is indispensable to minimise fire risks during further pre-treatment.

In most currently established waste treatment processes, "extended supply chain information" on substances of concern is not needed to support sorting processes in a feasible way and thus significantly improve the efficiency of these processes. Instead, rather aggregated and "simple" information on substances of concern and/or proper handling is needed.

According to the operators of disposal facilities, information on substances of concern in waste can be used well in practice especially if it:

- does not relate to individual substances, but substance groups and is aggregated,
- does not refer to the multitude of individual (partial) articles defined in the legislation, but to the assemblies/parts usually resulting from dismantling and separation processes,
- describes absolute contents and quantity proportions in equipment/assemblies or materials, and thus allows averaging for mixed waste fractions,

[91] expanded polystyrene

- is made available in a form that can be read and interpreted well under the real conditions of the respective (sorting) processes.

Even if the pragmatic "settings" necessary for this sometimes involve certain uncertainties, e.g. by addressing/eliminating an entire group of substances, even if individual compounds do not have any hazardous properties at all - the practitioners believe that significant improvements can be achieved in this way with a justifiable and practicable effort with regard to the materials kept in the cycle compared to the status quo.

Furthermore, in the area of very durable products, information on the absence of certain substances/substance groups ("free from...") is just as helpful as more differentiated information on harmful substances. Thus, waste from insulation boards with the explicit marker "Free of HBCD" could already be put into material recycling, even if unlabelled panels (with the corresponding HBCD suspicion) are in the building stock for decades to come.

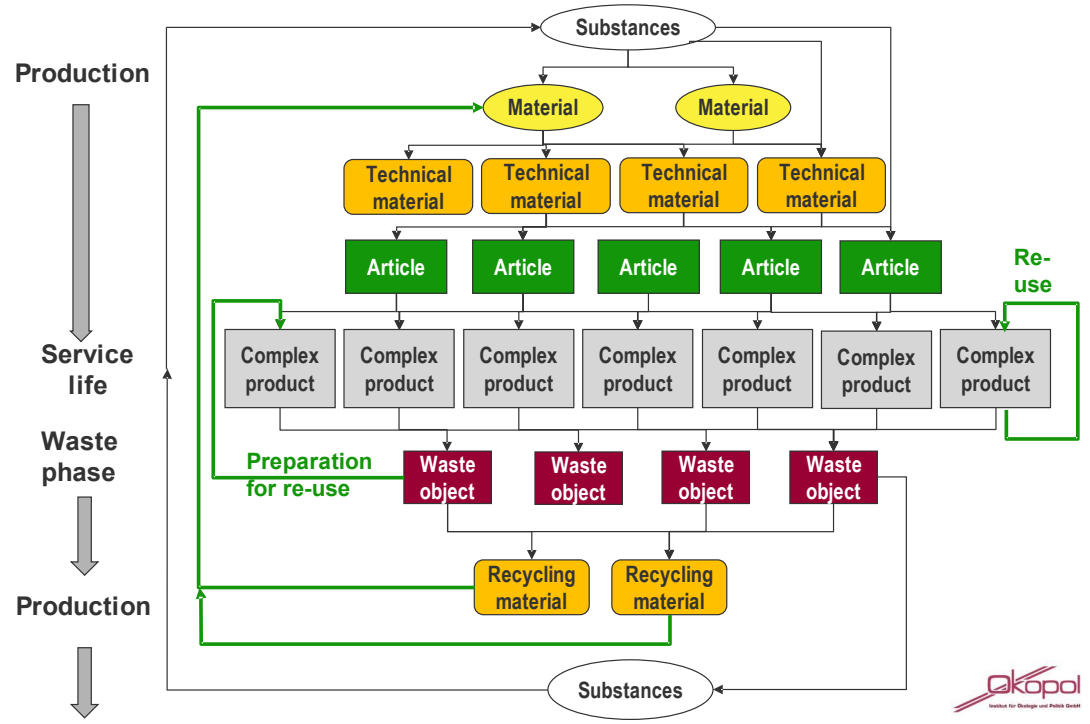
One reason for the significantly lower level of detail of the information required in the waste sector compared to the primary supply chain is the level of differentiation of secondary materials, which is also a magnitude lower than the technical materials and technical components of complex end products that are the target of primary supply chains.

The following diagram shows a simplified, schematic representation that a very large number of different mixtures are already produced from the chemical substances. These are used in different combinations to functionalise "technical materials", which in turn results in a large number of such materials, some of which have complex compositions and have been specifically optimised to meet specific technical requirements. In the subsequent production steps, these technical materials are in turn combined in a wide variety of combinations to form articles and complex products.

This wide variety of technical objects (materials, components and complex end products), which are then placed on the market for use, is not reflected on the waste side of the graph, which depicts the current situation.

Here, the waste products that have become waste are collected in a rather manageable number of waste streams compared to the primary products. In the course of sorting, separating and treating the waste fractions, recycled materials are obtained from them. In view of their number and the fluctuations in composition, these recycling materials are today mostly more comparable to the basic materials of the primary supply chains than to the specifically formulated technical materials.

Figure 36: Complexity of objects at different stages of the manufacturing and waste disposal processes



Source: own representation, Ökopol

Despite the undoubted complexity of material flows in today's waste management, from a "targeted material composition" perspective, they are an order of magnitude less differentiated than in the world of primary supply chains. Thus, under the current conditions, the level of detail of specific material information required here is also fundamentally different.

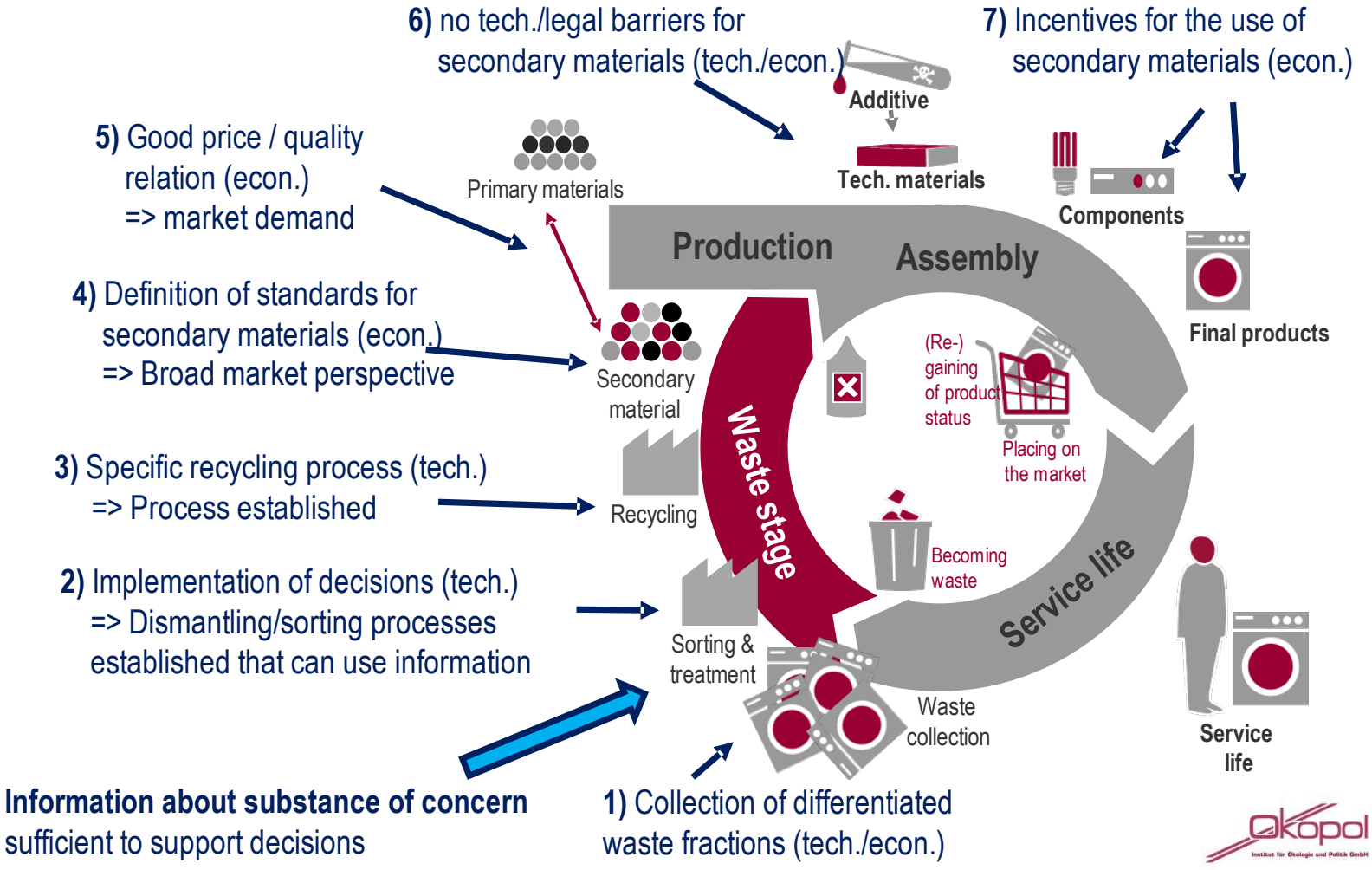
Only under the assumption that in the future a differentiated breakdown of the (end-of-life) products that have become waste will take place on a larger scale, down to the individual technical materials used, will more detailed information on the material-related composition of individual components in these (end-of-life) products actually be helpful. This detailed information can then support such very in-depth step-by-step dismantling processes.

In this context, information systems based on an interaction between an (electronic) marking of products (unique product identifier) and a database with detailed information on the (material) composition of the products may become more important. However, whether a complete deconstruction of products that have become waste down to the level of their original supplier parts/materials makes sense on a broader scale may be questioned, both in view of the fact that the preservation of the structure and purity of the materials requires energy and resources, and in view of economic marginal utility considerations[92].

Furthermore, in the discussion about the level of detail of substance information, it should be noted that the availability of substance information is only one of many prerequisites that are necessary for the establishment of high-quality closed-loop recycling of substances and materials. The following diagram shows a number of other prerequisites (1-7) that support the establishment of such closed-loop systems.

[92] Such discussions also reveal clear limits to the currently widely postulated universal solution potential of a "digital twin" or similar. Such a "digital twin", for example, loses most of its usefulness already at the first "mechanical breakage" of a component.

Figure 37: Prerequisites for improved waste treatment with regard to the content of substances of concern



Source: own representation, Ökopol

In addition to information about substances of concern, economic conditions must be met in order to increase the quantity and quality of secondary materials. These include, for example, the further separation of waste already during collection (point 1 in the figure). In addition, there is a need to develop material-related standards for secondary materials (point 4), which would provide guidance on the concrete goals of the respective sorting and processing processes and open up a broader market perspective. The removal of legal or technical barriers (point 6) and the creation of incentives (point 7) for the use of secondary materials by product manufacturers are also relevant factors. The necessary technical prerequisites include the establishment of processes and corresponding technologies/machines ("infrastructures") for the implementation of differentiated separate collection (point 1), the reading of information on substances of concern in sorting and disassembly processes with a subsequent (automated) sorting action (point 2) as well as the development and establishment of corresponding recycling processes that can also process (better) sorted material flows.

3.2.4 Approaches to strengthening information flows

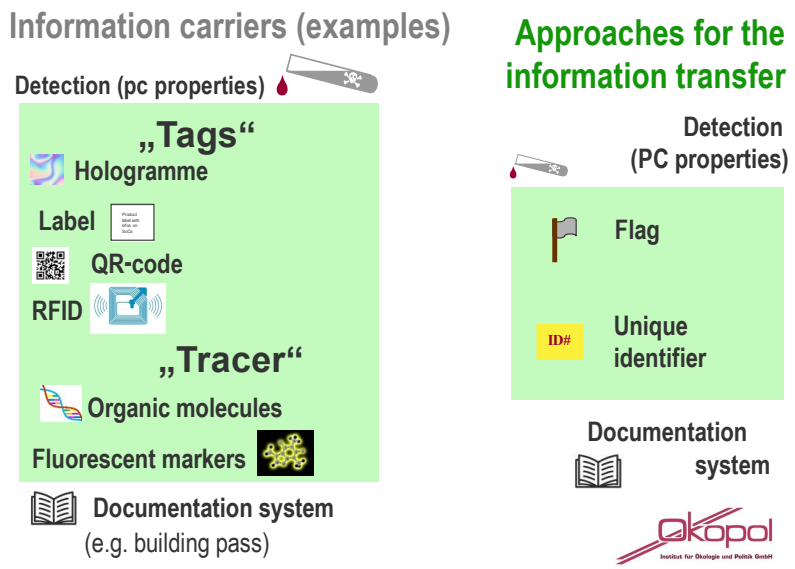
3.2.4.1 Possible elements of functional information transfer

When considering solutions for transferring the necessary substance information from the actors in the primary supply chains to those in the waste treatment chain, there are two key problems to overcome:

1. There is no clearly (pre-)defined relationship between the sender of the information in the supply chain and the receiver in the waste treatment.
2. Depending on the lifetime of the respective products, a not inconsiderable period of time (from a few weeks/days to > 50 years) can pass before the products (somewhere) reach the waste phase.

In principle, it is therefore a good idea to transfer the required information or part of it together with (attached to/included in) the product to the recipient. There are different possibilities for this, which are illustrated in the following figure.

Figure 38: Ways to communicate substance information to/with the product



Source: own representation, Ökopol

Figure 38 shows that a distinction must be made between the "physical form" of the information carriers (left) and the "content" of the transmitted information or the systematics of information transfer (right). For the discussion of the possibilities and limitations of information transfer, it is helpful to start with the "logical nature" of the information transferred.

Differences in approaches to information transfer

From the perspective of information logic, different approaches to the "transmission" of substance-related information can be distinguished (cf. Figure 38).

- With a **flag,** the information to be transmitted is transported directly on/with the respective information carrier, e.g. "This material contains substance X".
- In the case of the unique **identifier**, on the other hand, "only" the unique identity of the marked object is transmitted, e.g. in the form of a serial number. Based on the product identity, the recipient can search for the corresponding information in the database linked to the unique identifier and read it out.
- The direct detection of substances in materials on the basis of their **physical-chemical properties** is logically another approach to transmitting substance-related information directly with the product.
- In principle, it is also possible to store the substance inventory of a product in a **separate documentation** that is only indirectly connected to the product. In a building passport, for example, the composition of a product can be documented and identified by a location in the building.

The advantages of the unique identifier approach are that the amount of information that can be provided automatically is almost unlimited, and that this information can also be updated during the use phase of the product. When using flags, it is advantageous that the sender and receiver have to expend comparatively little effort to encode the information on the product or to read it out. Another advantage is the availability of different information carriers that enable both direct reading without additional aids and automatic reading and interpretation of the information, e.g. on the conveyor belt of a sorting system.

The physical information carriers and their suitability

Tags are applied to or in the surface of a product. The information can be directly "readable", as in the case of labels and symbols, or "machine-readable" and encrypted, as with barcodes, QR codes, holograms or RFID chips.

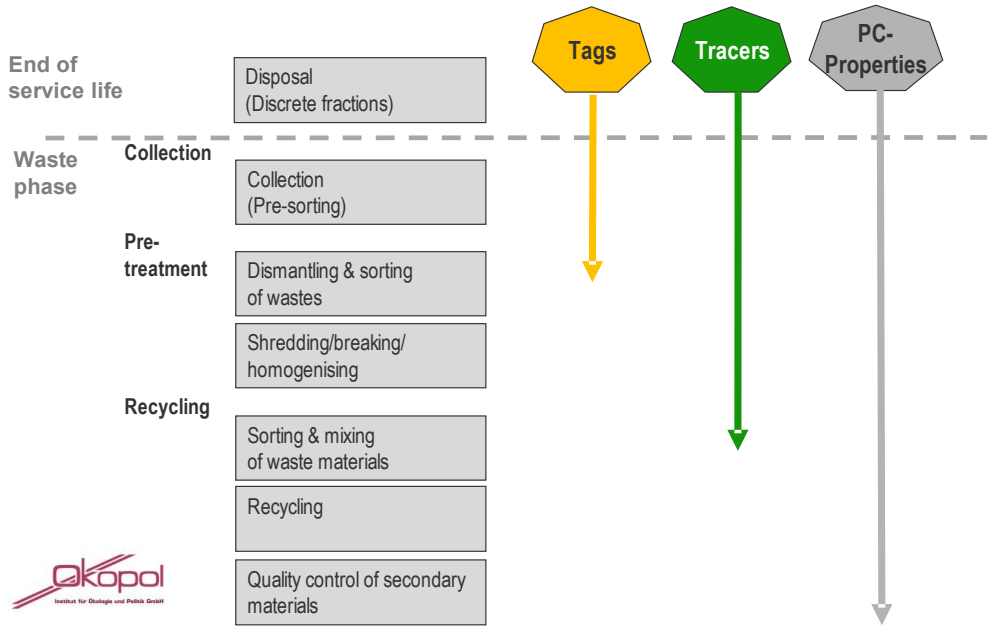
Tracers are introduced directly into the material matrix as easily detectable substances. So far, only "binary" information (tracer present/absent) can be transmitted in this way. Such additional tracers introduced into a material to communicate information about substances of concern "compete" with the direct detection of the respective substances in these materials using appropriate analytical methods (PC properties).[93]

The suitability of information carriers for the transfer of information into the waste treatment chain depends in particular on how far they can penetrate into the typical treatment processes without being destroyed (and thus losing the information). The following figure schematically

[93] Appendix XVIII of the InfoFlow study provides an up-to-date overview of the state of development of various information carriers and detection and analysis methods.

shows the penetration depths of the three types of information carriers into the waste treatment chain.

Figure 39: Depth of penetration of information carriers into waste treatment chains



Source: own representation, Ökopol

Tracers can withstand even harsh conditions during service life and waste treatment. Therefore, they also reach the downstream sorting and process steps in the waste treatment chain up to the actual material recycling. Tags such as labels, barcodes or RFIDs, on the other hand, are much more sensitive. They can already be destroyed by "improper" use or by "physical" stress[94] during waste treatment and, thus losing their function. Therefore, they are more suitable for informing the earlier steps in waste treatment. Transporting complex (substance) information to the end of the recycling chain (manufactured recycled materials) is currently not possible with any of these techniques. However, the PC properties of a secondary material can be analysed and thus information on the content of substances of concern can be obtained.

The usability of information carriers is limited on the one hand by the fact that they can be destroyed or separated from the end-of-life products/products that qualify them (technical limits or "depth of penetration" as shown in the Figure 39 illustrated). On the other hand, although an information carrier may enter the waste phase intact and attached to the product, its function may be limited by the fact that the product is broken during treatment. As a result, this part can be separated from the information carrier and thus transport information that is no longer relevant to the "leftover part" of the product to which it is attached. Another aspect that influences the penetration depth of information carriers is the fact that the context in which the transported information is "correct" can be lost when waste fractions are mixed.

3.2.4.2 Applicability of the various solution elements

The possible information needs of actors at different points in the waste treatment and recycling chain have been described above in a prototypical way by the four basic intervention

[94] E.g. due to moisture during environmental collection, due to decanting processes of the collection containers or at the latest during a (pre-)treatment process such as shredding.

mechanisms. The following diagram shows the extent to which the different approaches to information transfer are suitable to satisfy this need for information.

Figure 40: Applicability of the approaches to the transfer of necessary information for the four basic mechanisms

	Mechanism A Sorting at the product's end of life	Mechanism B Preparation for re-use	Mechanism C Sorting of products and components	Mechanism D Improved material sorting
Detection (PC properties)	Sometimes applicabe	Not applicable	Seldom applicable	Sometimes applicable
Flag-based with tracers	Applicable	Not applicable	Applicable	Sometimes applicable
Flag-based with labels and codes etc.	Applicable	Sometimes applicable	Sometimes applicable	Not applicable
Unique identifier	Sometimes applicable	Applicable	Seldom applicable	Not applicable
Documentation	Seldom applicable	Seldom applicable	Not applicable	Not applicable

Source: own representation, Ökopol

The table also shows that the mechanism D can only be "informed", if at all, by information carriers that are directly interwoven with the material. Documentation-based approaches are in principle rarely applicable, just as the detection of PC properties is of limited practicality. Flag-based approaches using tracers and more complex information carriers are limited to mechanisms A to C, but are partly well applicable.

Despite the vagueness of such a consideration across all waste fractions and sorting processes, it becomes clear that there is no "one-fits-all" solution, but rather that each case must be carefully examined to determine which solution is best suited for which task.

In the InfoFlow study, it was shown that information transfer with tags and tracers would cause relatively low costs compared to approaches with a unique identifier in combination with a database. The reason for this is the relatively complex IT infrastructure required for unique identifier approaches. In addition, at least an industry-wide agreement on harmonised data structures would be necessary, as well as the possibilities for access and reading of information by waste actors.

In practical implementation, flag-based approaches should not be underestimated, as they can generate significant benefits in a short time and with little effort. As substance information cannot be updated in these approaches, they are particularly suitable for short-lived products such as packaging materials or clothing textiles. In addition, they also offer solution perspectives for areas in which a "simple" but long-term recycling problem can already be identified today.[95] The "simple" approaches can also become highly significant in preparation for the transition

[95] One example here is the marking of composite thermal insulation systems as "free of brominated flame retardants" in order to have a clear sorting criterion for possible recycling for disposal (in approx. 30 - 50) years.

from current to future waste treatment and organisation of material flows and initiate a corresponding, step-by-step process.[96]

The more elaborate, database-based systems allow a higher level of differentiation and updating of data over the product life cycle. They are therefore suitable for long-lasting and complex products as well as for products for which a differentiated disassembly makes sense or will be legally prescribed and, if necessary, also suitable for the reuse of technical materials and/or components.

The lack of information transfer about substances of concern in products into the waste phase is not due to a lack of possible solutions. Rather, the actors in the waste management sector are (still) unsure how they can build business models in cooperation with manufacturing industries and buyers of recycled materials that will refinance the expense of additional sorting and separation processes in the medium and long term. However, also due to the current environmental policy framework, it can be assumed that different approaches for information flows about substances of concern in products to the waste sector will be discussed in order to decontaminate material flows and to be able to produce less polluted secondary materials.

Product group and sector-based approaches are more likely to be met with stakeholder approval than cross-sectoral approaches. However, the latter are essential for directing relevant volumes of waste material to specialised recycling facilities and generating high-quality secondary material streams. Sectoral approaches are primarily helpful for waste collection and early sorting steps, and for products that are largely "individually" treated. Cross-industry and cross-sectoral approaches are adequate and necessary for the later sorting processes. On an overarching level, secondary material qualities should be defined in such a way that recycled materials can substitute for high-quality, primary technical materials across a broad range of applications. In this way, demand can also be generated and corresponding financial incentives created that allow the necessary investments in the waste treatment chains to be refinanced.

3.3 Expert Dialogue 2 and its results

3.3.1 Framework conditions

The Expert Dialogue 2 on the topic of "Information flow on substances of concern at the interfaces of chemicals and waste legislation: requirements and needs as well as challenges and approaches to solutions" was held as a web conference on 23 September 2021 from 09:00 - 15:00.

A total of 24 people took part in this dialogue. The central actors answering core questions were well represented by the workshop participants. Representatives from the state and federal administration, companies from primary production and recycling as well as experts in waste sorting technologies took part in the event.

The schedule of the dialogue, the presentation slides as well as the results protocol agreed to with the participants can be viewed on the project website at **https://oekopol.de/themen/ressourcen-und-kreislaufwirtschaft/fachdialoge-abfallrecht-chemikalienrecht/.**

[96] Even when using central database systems, there is hardly any need to use sensitive information in the conceivable use cases examined in more detail so far. Rather, the degree of aggregation of the helpful data is predominantly so high and the information so general that no business secrets or other protected assets are affected. This puts the often intensively discussed question of data security into perspective.

3.3.2 Selected discussion points

Some key points from the discussions of the expert workshop are given below.

3.3.2.1 Fundamental importance of the topic

In particular, the representatives from the waste treatment and recycling sector stressed that they need additional, meaningful information (on substances classified as hazardous) if they are to meet the Green Deal's objectives of significantly strengthening the recycling of materials and articles. At the same time, in their opinion, it is not sufficient to "only" strengthen the flow of information. Rather, this would have to go hand in hand with a "design-for-recycling" so that problematic ("hazardous") ingredients either do not get into the waste mixtures in the first place or can at least be easily and specifically diverted.

Some stakeholders pointed out that the (additional) effort for information transfer should not be disproportionate for the market actors involved (especially in the area of manufacturers and trade).

3.3.2.2 Structure of the functions of information on "hazardous" substances in the life cycle

The scheme developed by Ökopol of the entry paths of substances of concern into the value chain and the presentation of the possible functions of substance information at the different stages of waste treatment were considered helpful. The intervention mechanisms for improved circular material flows based on additional substance information also have an appropriate degree of abstraction in the opinion of the participants. They thus form a very good basis for a structured discussion on the possible uses and the necessary contents of information transfer.

3.3.2.3 Information exchange initiatives

All participants were of the opinion that communication and cooperation between the participants in the material cycles are central prerequisites for well-functioning solutions. However, these prerequisites were partly missing and stronger incentives for communication and cooperation would have to be created. The most effective incentives would be those that are driven by the users' business models. According to the participants, such "driving" business models are currently hindered by the fact that economically self-supporting material recycling solutions could not be established in many areas. This is due in particular to the fact that the established collection structures for waste fractions are so heterogeneous that the separation and sorting effort is not, or cannot be, in any meaningful proportion to subsequent material revenues.

It was considered useful for the actors in the waste treatment chains to first clarify among themselves exactly what information they need, and then to enter into an exchange with the actors in the primary supply chains about suitable forms of information transfer. Such a dialogue would have to be conducted on an ongoing basis because the treatment technologies are developing dynamically and increasing digitalisation would also offer new opportunities. A "neutral" platform for information exchange established by the environmental administration could be helpful here.

Primary manufacturers stated that possible additional requirements for the disclosure of substance information should always be measured in terms of their value for the establishment of circular material flow models and should not be seen as a value in itself.

3.3.2.4 Requirements for the material quality of secondary materials

The majority of participants shared the view that clearly defined "target qualities" for secondary materials both facilitate the orientation of waste management sorting processes and promote the sale of recycled materials.

While the targeted blending of different recycled materials to achieve such quality targets was considered sensible and necessary by some participants, others considered it counterproductive. On the other hand, there was widespread agreement that deliberately allowing recyclates to have "inferior qualities" compared to primary raw materials would not be effective.

Various participants felt that the sameness of primary and secondary materials should be based on a risk assessment. This would mean that the risk potential for a defined use pattern should be comparable. On the other hand, it could not be a matter of reproducing the material composition of primary raw materials in secondary raw materials 1:1.

It was discussed that the currently still predominant concept of undefined and thus (almost arbitrarily) broad use patterns for recyclates is no longer sustainable. This is the case, among other things, because substances are introduced into the environment through broad uses and can no longer be removed from it later.

3.3.2.5 Information on hazardous substances in waste fractions

All stakeholders supported activities to label products that contain particularly problematic ingredients in order to enable separate treatment. One example is electrical appliances that contain Li-ion batteries.

For the sorting processes, it is particularly important how quickly such devices can be identified and sorted. The participants expressed the view that identification and sorting only have a chance of being implemented in practice if they can be read with reasonable effort and at the usual belt speeds of large sorting systems. Another limitation of the possibilities to differentiate the sorting processes results from the practically realisable number of sorting fractions in the sorting plants.

The participants agreed that there is no "one-fits-all" solution for information transfer. The sorting technology as well as the instruments of information transfer would have to be adapted to the respective material flow. This became clear from the examples of WEEE and plastic packaging, which were discussed in depth have fundamentally different sorting requirements and recycling possibilities.

4 Expert Dialogue 3 – Strengthening the waste hierarchy

4.1 Main topic

In the European and national context, the political impetus for sustainable and circular economy is currently increasing. Within the framework of the European Green Deal[97] , the Chemicals Strategy for Sustainability[98] and the Action Plan for the Circular Economy[99] have already been published. An initiative for the sustainable design of products is in the pipeline.

The political guidelines from these initiatives are directed, among other things, towards the goal of a pollution-free environment. For this, the priorities are clear and build on the principles in place:

- The prevention/reduction of the use of substances of concern and of waste with hazardous ingredients;
- A waste treatment that feeds the largest possible quantities of products to a preparation for reuse[100] that is safe (from a material point of view) and that complies with the legal requirements;
- Waste treatment that converts as large a material stream as possible into secondary materials. This should either exclude the recycling of substances of concern or ensure that contaminated secondary materials are only used in well-controlled applications;
- The removal of substances with (particularly) hazardous properties from material cycles.

In order to be able to implement these goals of the EU Green Deal, actors in the waste sector need guidance on how to address and implement the legally defined waste hierarchy in waste treatment practice with regard to the content of substances of concern in the waste streams.

Against this background, the third dialogue workshop of the overall project focused on the topic of "Strengthening the waste hierarchy: decision-making aids for the selection of treatment pathways".

4.2 Technical background on the implementation of the waste hierarchy for wastes containing hazardous substances

In the following explanations on the technical background, which legal requirements the actors of waste management have to observe when selecting the treatment paths of waste, which challenges they are confronted with and where there is a need for support is described.

[97] EU Commission (2019): COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS The European Green Deal. COM(2019) 640 final https://eur-lex.europa.eu/legal-content/DE/TXT/?uri=CELEX:52019DC0640

[98] EU Commission (2020): COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Chemicals Strategy for Sustainability Towards a Pollutant-Free Environment. COM(2020) 667 final, https://eur-lex.europa.eu/legal-content/DE/TXT/?uri=CELEX:52020DC0667

[99] EU Commission (2020) COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS A new action plan for the circular economy Towards a cleaner and more competitive Europe. COM(2020) 98 final, https://eur-lex.europa.eu/legal-content/DE/TXT/?uri=CELEX%3A52020DC0098

[100] Direct reuse is only possible if a substance or product does not meet the waste definition, i.e. is also not subject to the law applicable there, but must then be treated in accordance with the applicable chemicals and product law.

4.2.1 Waste legislation requirements

In Germany, the KrWG[101] transposes the requirements of the Waste Framework Directive (WFD; Directive 2008/98/EC[102]) into national law. According to KrWG §1 para. 1, resources must be conserved, and people and the environment must be protected in the management of waste. The WFD mentions the protection of the environment and health as an overarching goal, which should be achieved by reducing or avoiding the harmful effects of waste management as well as by reducing the negative effects and increasing the efficiency of resource use.

Consequently, according to the applicable waste legislation, both at EU level and nationally, the objectives of environmental and health protection as well as the sustainable management of natural resources are guiding principles for action. It is not clearly defined how these objectives can or should be measured and, if needed, weighed against one another at the national or EU level.

4.2.1.1 The hierarchy in waste treatment

In accordance with the requirements of EU legislation on the waste hierarchy, Article 6 (1) KrWG establishes an order of priority for measures of prevention and waste disposal, which is decisive for the management of waste and must be implemented while taking into account the possible effects of the procedures on human health and the environment. These measures are ranked as follows:

4. Prevention[103],
5. Preparation for reuse,
6. Recycling,
7. Other recovery, in particular energy recovery and backfilling,
8. Elimination.

This hierarchy is also found in a comparable form in § 5 para. 1 no. 3 BImSchG and thus also defines a guiding principle for the operators of installations requiring a permit.

§ Section 6 (2) KrWG further states that the impacts of waste management on humans and the environment must be considered over the entire life cycle of the waste, i.e. including a second service life if necessary.

> *"In particular, the following should be taken into account*
>
> 1. *the emissions to be expected,*
> 2. *the degree of conservation of natural resources,*
> 3. *the energy to be used or recovered, and*
> 4. *the accumulation of pollutants in products, in waste for recovery or in articles derived therefrom.*
>
> *The technical possibility, the economic reasonableness and the social consequences of the measure shall be taken into account."*

Furthermore, sentence 3 of Article 7(2) in conjunction with Article 15 KrWG states that the hierarchy of disposal options does not apply if the removal best ensures the protection

[101] Act to Promote Closed Substance Cycle Waste Management and to Ensure Environmentally Sound Management of Waste (Closed Substance Cycle Waste Management Act - KrWG), https://www.gesetze-im-internet.de/krwg/

[102] European Commission (2008): DIRECTIVE 2008/98/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 November 2008 on waste and repealing certain Directives, latest consolidated version 05/07/2018 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008L0098-20180705

[103] Prevention means both to avoid the generation of wastes (quantity) as well as to avoid hazardous properties in wastes (quality).

objectives, e.g. if a waste contains substances of concern that pose a risk of entering products with critical exposures to humans and the environment in the second life cycle. This is reinforced by the requirement of harmless treatment, which is defined by the absence of impairment of public welfare, especially with regard to the accumulation of pollutants in the streams of recyclable materials (Article 3(4) KrWG). Here, Section 6 (2) KrWG also refers to the fact that aspects of the precautionary and sustainability principles must be taken into account when selecting measures.

Section 7 (4) KrWG relativises the requirements to the effect that priority recovery should be technically possible and economically reasonable. Economic reasonableness is deemed to exist if the costs of recovery are "*not disproportionate*" to those of disposal[104].

According to Section 8 (1) KrWG, producers and holders of waste are required to consider how waste can be recovered in a way that best ensures the safety of humans and the environment and under which circumstances there is a right to choose between the recovery measures of the different hierarchy stages according to Section 6 KrWG.

Pursuant to Article 8(2) of the KrWG, the Federal Government, after hearing the parties involved (Article 68 of the KrWG), shall decide by ordinance and with the consent of the Bundesrat on certain types of waste based on the criteria laid down in Article 6(2), sentences 2 and 3 of the KrWG:

1. the priority or equal priority of a recovery measure; and
2. requirements for the high quality of the recovery.

A statutory instrument pursuant to Article 8(1) KrWG may stipulate in particular that the recovery of waste must be carried out in accordance with its type, nature, quantity and constituents by means of multiple, successive material recovery and subsequent energy recovery measures (cascade recovery).

The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMUV) has published two guideline documents on the basic interpretation of the waste hierarchy and on the ranking of recovery measures, which contain some fundamental clarifications on the subject.

- "Guideline for the application of the waste hierarchy according to § 6 KrWG - hierarchy levels recycling and other recovery".[105]
- Implementation Guideline "Hazardous Waste from Industrial Processes, the Energy Recovery of which is Considered to be of Equal Priority to the Material Recovery Processes Pursuant to Section 8 Para. 1 Sentence 2 in Conjunction with Section 6 Para. 2 KrWG". § 6 para. 2 KrWG".[106]

In summary, the waste hierarchy is based on the assumption that by applying it, the best option in terms of waste legislation and waste policy from an ecological point of view is used for waste management[107]. There is some room for interpretation because harmful effects on humans and

[104] Cf. on these aspects also the detailed document of the BMUV (Guideline on the application of the waste hierarchy according to § 6 of the Closed Substance Cycle Waste Management Act (KrWG) - Hierarchy levels recycling and other recovery (as of 25.09.2017)) https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Abfallwirtschaft/krwg_leitfaden_abfallhierarchie_bf.pdf

[105] https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Abfallwirtschaft/krwg_leitfaden_abfallhierarchie_bf.pdf

[106] https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Abfallwirtschaft/vollzugshilfe_gefaehrliche_abfaelle_bf.pdf

[107] Cf. recital 31 WFD

the environment must be considered for each specific waste. In addition, economic and technical aspects can justify a deviation from the hierarchy of recovery options.

The first priority of the waste hierarchy was not relevant for the question posed at the dialogue workshop, as the prevention of waste was not the subject of the discussion because the dialogue content focused on aspects of waste treatment.

4.2.1.2 Quantitative targets for waste management

Quantitative targets for waste treatment are defined in the EU and at national level. "Collection quotas" define the percentage of new products placed on the market that are to be collected and recorded separately after reaching waste status. Recycling quotas define the percentage of waste generated or collected from these products that is to be sent to a recycling process. In Germany, these targets are secured by means of product responsibility.

An example of a collection rate can be found in Article 10 (2) of the EU Battery Directive[108]. This stipulates that Member States had to ensure that at least 45% of batteries placed on the market are collected separately by September 2016.[109]

An example of recycling quotas can be found in EC Directive 94/62[110] for packaging and packaging waste. The following targets are defined here, among others:

- Recycling of 70% of all packaging waste by 31.12.2030[111]
- Material-specific recycling quota[112] by 31.12.2025 / 31.12.2030 as a proportion of packaging materials placed on the market
  - Wood 25/30 %,
  - Plastics 50/55 %
  - Aluminium 50/60 %,
  - Glass 70/75 %,
  - Ferrous metals (FE metals) 70/80 %,
  - Paper, cardboard and carton je 75/85 %

Overall, these quotas are therefore of a quantitative nature and do not impose any qualitative requirements with regard to the material composition of the waste or secondary materials produced. Moreover, they do not specify how the quantitative targets are to be achieved. Thus, the quotas in waste legislation only restrict the treatment path to the extent that they:

- set a quantitative lower limit for recycling (recycling quota) and thus create incentives for recycling and

[108] DIRECTIVE 2006/66/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC

[109] In Germany, the Act on the Sale, Return and Environmentally Sound Disposal of Batteries and Accumulators (Battery Act - BattG) §16 stipulates a minimum of 50% https://www.gesetze-im-internet.de/battg/BJNR158210009.html

[110] Directive 94/62/EC of the European Parliament and of the Council of 20 December 1994 on packaging and packaging waste https://eur-lex.europa.eu/legal-content/DE/TXT/HTML/?uri=CELEX:31994L0062&from=DE

[111] Here, the target rate of 65% still applies until 2025.

[112] Transposed in Germany in §16 Packaging Act (VerpackG) https://www.gesetze-im-internet.de/verpackg/BJNR223410017.html

- specify the minimum proportion of a waste stream with a composition defined at least by the material or the end-of-life product to be collected.

4.2.1.3 Limitations of treatment routes due to the presence of hazardous components of the waste

In principle, the requirement of "generally acceptable disposal" according to KrWG applies primarily to waste streams that cannot be recycled properly and without harm. This applies to both non-hazardous waste and hazardous waste (cf. Sections 7 and 15 KrWG).

The classification of a waste as hazardous triggers various legal consequences (see chapter 2.2.6), which (may) influence the handling and the selection of the procedure for treatment. The requirements for storage, transport and documentation[113] are generally less relevant. More important are any resulting limitations on the possible treatment processes, e.g. in cases where facilities have to be licensed for the respective (hazardous) wastes and/or where there are requirements for the handling of certain wastes in facilities. Another factor that can be (partly) decisive for treatment pathways is the intended use of the recovered secondary material. Furthermore, there are legal requirements for the treatment of certain waste streams (e.g. in the Backfill Ordinance, Sewage Sludge Ordinance, Biowaste Ordinance, End-of-Life Vehicles Ordinance, the Ordinance on the Treatment of Waste Electrical and Electronic Equipment, the Waste Oil Ordinance, etc.).

For hazardous waste, § 9a KrWG prohibits mixing including dilution (see chapter 2.2.6). Isolated exceptions are possible under certain circumstances if this corresponds to the state of the art and the process takes place within the framework of proper, harmless recovery. It must be taken into account that this process does not lead to an increase in harmful effects of waste treatment on humans and the environment and that the mixing of waste types only takes place in appropriately licensed facilities. On the one hand, these exceptions to the mixing ban can expand the spectrum of possible treatment pathways for hazardous waste, but on the other hand they can also lead to uncontaminated and contaminated material streams (from different waste sources) being mixed together. In this way, the substances of concern contained are distributed in this material stream, and previously high-quality (unpolluted) material streams become contaminated, reducing their value. This is particularly true if materials are to be transferred again to the scope of product and chemicals legislation, thereby circumventing concentration limits to be complied with there. In other cases, however, the mixing may also pursue other waste management objectives, where other framework conditions apply and the content of certain pollutants may be considered of secondary importance (e.g. in the case of energy recovery from waste, where extensive destruction of the pollutants can be assumed or where they can be handled in terms of plant technology).

Waste streams containing pollutants listed in Annex IV of the EU POP Regulation[114] above the limit values defined therein must, according to Article 7 (2), be recovered or disposed of in such a way that these substances are either destroyed or irreversibly transformed. It is permissible to separate these substances from the rest of the waste stream and then dispose of them separately.

[113] This depends on the waste composition. In this context, the regulations of transport and immission control apply.

[114] REGULATION (EU) 2019/1021 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 June 2019 on persistent organic pollutants.

The AVV also stipulates[115] that waste containing the substances [...*polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/PCDF), DDT (1,1,1-trichloro-2,2-bis(4-chlorophenyl)ethane), chlordane, hexachlorocyclohexanes (including lindane), dieldrin, endrin, heptachlor, hexachlorobenzene, chlordecone, aldrin, pentachlorobenzene, mirex, toxaphene, hexabromobiphenyl and/or PCBs in concentrations exceeding the concentration limits laid down in Annex IV to Regulation (EU) 2019/1021 of the European Parliament and of the Council (2)"* are classified as hazardous (cf. Annex to the Introduction to the AVV, Number 2.2.3). In addition, certain wastes containing POPs above the limit values of Annex IV of the POP Ordinance are subject to the Ordinance on the Separate Collection and Monitoring of Non-hazardous Waste Containing Persistent Organic Pollutants (POP Waste Monitoring Ordinance - POP-Abfall-ÜberwV)[116]. This ordinance imposes requirements for the verification of the disposal path and the separation of the waste streams (in cases where the POP waste classified as non-hazardous waste in § 2 POP-Abfall-ÜberwV).

4.2.2 Requirements of chemicals legislation

The EU chemicals legislation consists of various regulations[117] , which regulate the placing on the market and the handling of chemicals. In the following, mainly the possible influence of the REACH regulation on waste treatment is presented and discussed. Further regulations are explained if necessary for the understanding how they might limit the waste treatment options.

4.2.2.1 Limitation of a treatment pathway through REACH registration

Chemical Safety Assessment

Manufacturers and importers of substances must register them under REACH. With a registration, information on the hazardousness of the substances, among other things, must be submitted. The type of information to be submitted depends on the registered quantity.

If more than 10 tonnes of a substance are registered per year and per actor, a chemical safety assessment[118] must be carried out. If the substance has hazardous properties, this chemical safety assessment must include an exposure assessment and a risk assessment to demonstrate, among other things, that a substance does not pose unacceptable risks in the intended uses (e.g. as a component of mixtures or articles). If necessary, it must be determined which risk management measures are necessary and must be implemented for a "safe use". This assessment is documented in the so-called Chemical Safety Report, which has to be submitted to ECHA by the companies subject to registration as part of the registration dossier.

The chemical safety assessment should include the waste phase of the registered substances and, analogous to the use in mixtures or articles, define which measures, if any, are necessary to enable safe waste treatment. This could be interpreted to mean that a manufacturer includes in his assessment that a substance is not suitable for chemical-physical treatment and therefore

[115] Implementation of the requirements of Commission Decision 2014/955/EU on the establishment of a waste list pursuant to Article 7 of Directive 2008/98/EC http://data.europa.eu/eli/dec/2014/955/oj

[116] For unlisted POPs, no classification as hazardous waste is made if the limit values from Annex IV of the POP Regulation are exceeded. However, it should be noted that there may be other reasons for classifying the waste as hazardous waste, e.g. if the presence of the substance fulfils another test criterion for hazardous waste from Annex III of the WFD (e.g. HP 14 - ecotoxic (harmful to the ozone layer, harmful to the aquatic environment)).

[117] In general, all regulations that govern the marketing, transport, storage and use of substances or mixtures in the EU are counted as chemicals legislation, in particular the REACH and CLP regulations, the regulations on biocides, plant protection products, cosmetics and detergents, as well as pharmaceutical legislation. Furthermore, the regulations that implement international agreements, such as the POP Regulation or the Regulation on the Import and Export of Hazardous Chemicals (PIC).

[118] Cf. Article 14 of the REACH;

excludes this treatment method. This would be communicated with the safety data sheet along with the conditions of safe use.

Consequently, the chemical safety assessment may result in restrictions for the treatment path of a substance (in a material stream), which, however, would only be relevant for commercially used mixtures and/or production waste due to the communication gap[119] for consumer products (see chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**).

The manufacturers of articles do not have to prepare a chemical safety assessment, but they are nevertheless obliged to provide information if their article contains a substance from the REACH candidate list in concentrations >0.1 % by weight (cf. Art. 33 REACH).

Registration obligation of recovered substances

Wastes are excluded from the scope of REACH (cf. chapter 1.3.1). Substances "produced" by a recycling process in turn fall (again) within the scope of REACH and thus must in principle be registered by the recycling company.

The so-called "recycling privilege" in Article 2 (7d) REACH formulates an exemption from the registration obligation if substances are recovered as such, in mixtures or in articles from recycling processes in the EU. In order to be able to make use of this exemption, two conditions must be met: a) the recovered substance is identical to an already registered substance and b) the company carrying out the recovery has appropriate safety information for the use of the substance, e.g. in the form of an SDS.

The possibility of selecting recycling processes as waste treatment paths is thus limited by chemicals legislation in that the recycling company must have sufficient knowledge about the recovered substances (identity) and corresponding information for registration or exemption.

4.2.2.2 Narrowing down the treatment pathway through the approval process

SVHCs under REACH, which are included in Annex XIV of REACH, may in principle only be used in the EU after a fixed date (sunset date) if the applicant company has been granted an authorisation for this by the EU Commission.

The handling of secondary materials[120], e.g. decanting or packaging as well as the incorporation of such materials into articles, is considered a use under REACH. Thus, recycled materials containing substances subject to authorisation would require authorisation both for the recycler itself and for its customers who use these materials. As authorisation applications are specific to the respective value chains, the activities of the recycling companies and their customers are not covered by other authorisations, as is the case for registration under Article 2 (7d) REACH.

In this respect, the authorisation requirement is an indirect restriction of the decision-making scope on the treatment options of waste (containing SVHC subject to authorisation). Without a corresponding authorisation, i.e. an explicit official permit, neither the handling at the recycling plant is in compliance with the law, nor will there be a market for the materials once they have reached the end of their waste life.

In addition, it is possible that a review of potential risks at the end of the (primary) substance use is carried out within the framework of an authorisation decision. This can lead to the formulation of framework conditions for the respective use, which also includes the disposal of

[119] Cf. the relevant remarks in the context of Expert Dialogue 2.

[120] In other words, waste that has reached the end-of-waste stage within the meaning of Article 6 of the WFD. And are thus again considered as products to which REACH and further-reaching product legislation fully (re)applies.

the (primary) substance after its use. If such conditions become part of the authorisation conditions, they are a binding prerequisite for continued use and can thus restrict the possible disposal pathways. According to current experience, no concrete waste treatment processes are specified, but rather framework conditions (e.g. obligation to use treatment processes that prevent emissions to water).

4.2.2.3 Narrowing down a treatment pathway through the restriction procedure

The restriction procedure under REACH allows authorities to ban (certain) uses of substances completely or to formulate conditions under which they are acceptable. The prerequisite for this is proof of a risk, the control of which requires EU-wide measures. This risk can also arise from the treatment of waste and can therefore be cause for restriction.

Similar to the REACH regulation, the mechanism to restrict substances is also implemented in other regulatory instruments, e.g. the POPs Regulation or the Directive on the Restriction of Substances in Electrical and Electronic Equipment (RoHS)

In addition to the ban on substances, the POP Ordinance contains further concrete regulations for the management of waste (Article 7 POP Ordinance). This article prescribes the following for waste management:

- Producers and holders of waste shall ensure that their waste is not contaminated with fractions containing POPs (mixing ban).
- Waste containing POPs above defined thresholds should only be managed in such a way that the POPs it contains are destroyed or irreversibly transformed.
- Recycling of POPs is prohibited in any case.
- In addition, Member States are required to take measures to track waste containing POPs, which in Germany is done within the framework of the POP Waste Monitoring Ordinance.

The restriction on the content of substances in products (mixtures and/or articles) is also valid for products that are placed on the market again after preparation for reuse. In the case of long-life products in particular, it is possible that restrictions enter into force during their service life, which did not exist when the product was first placed on the market. Since there is usually no information available on the content of substances of concern in products, compliance with the legal requirements is often not possible with certainty.

The possibility to recycle products or material streams can also be limited by defining concentration thresholds for substances in the context of restrictions that cannot be safely met in "mixed waste streams", but also in well-defined waste. Possible determining factors for compliance with a concentration threshold are the type and extent of the pollutant under consideration and the service life of the individual products.

For example, lead (CAS no. 7439-92-1) has a harmonised classification as a reproductive toxicant of category 1A within the framework of a scientific process and as a decision of the EU Commission, which made further regulations necessary to protect human health and environmental organisms. In 2020, a restriction proposal for lead was therefore introduced at the EU level under REACH and a limit value for the recycling of rigid PVC in construction profiles was controversially discussed. The limit value proposed by the EU Commission would in principle allow recycling of rigid PVC with lead stabilisers. With the lower value demanded by the EU Parliament, it is uncertain whether the requirement can be met at any time due to waste stream-induced fluctuations in the concentration of lead in rigid PVC. In the area of window

profiles, for example, it must be expected that, due to the lead content in old windows (> 10 - 15 years in use), concentrations may still occur in recycled PVC in the future that lead to the lower limit value being exceeded, even though the use of lead has been very limited in the recent past. As a result, the Parliament rejected the proposal with the higher limit value and a final decision on this restriction has not yet been made (as of 09. 2022).

4.2.2.4 Limitation of a treatment pathway by the information obligation on SVHC in articles (REACH Art. 33)

According to Art. 33 REACH, at least the identity of SVHCs contained in articles in concentrations above 0.1 wt. % must be communicated in the supply chain and also passed on to consumers upon request. This information obligation is particularly relevant for companies that prepare articles for reuse and place them on the market again. Currently, however, this obligation is hardly implemented[121]. This results in a conflict between the goal of the longest possible service life of (materials) in products and the goal of a "toxic-free environment", which requires the removal of particularly hazardous substances from material cycles.

To what extent and how this information requirement will be supported by the SCIP database established by ECHA according to Art. 9(2) of the WFD 2008/98 amended in 2018 can only be analysed in the coming years. Furthermore, companies producing articles directly from recycling processes or using secondary materials for the production of articles could only fulfil the communication requirement if the information on SVHC is communicated further through the waste treatment chain and by the recycler.

4.2.2.5 Limitation of a treatment pathway through classification and labelling

Classification and labelling under chemicals legislation have a direct influence on the classification and thus also on the (further) treatment of (hazardous) waste. This has already been explained in the chapter 4.2.1.3.

4.2.3 Selection of suitable treatment pathways

The legal framework limits the possibilities of a "free choice" for the waste treatment path. Within these limits, the waste hierarchy can be implemented in different ways. The identification of an "optimal waste treatment" should balance the goals of "resource conservation" and "protection of health and the environment from toxic and ecotoxic risks". The KrWG names four parameters for the weighing process (§ 6 para. 2 KrWG):

- the expected emissions,
- the degree of conservation of natural resources,
- the energy to be used or recovered, and
- the accumulation of pollutants in articles, in waste for recovery or in articles derived therefrom.

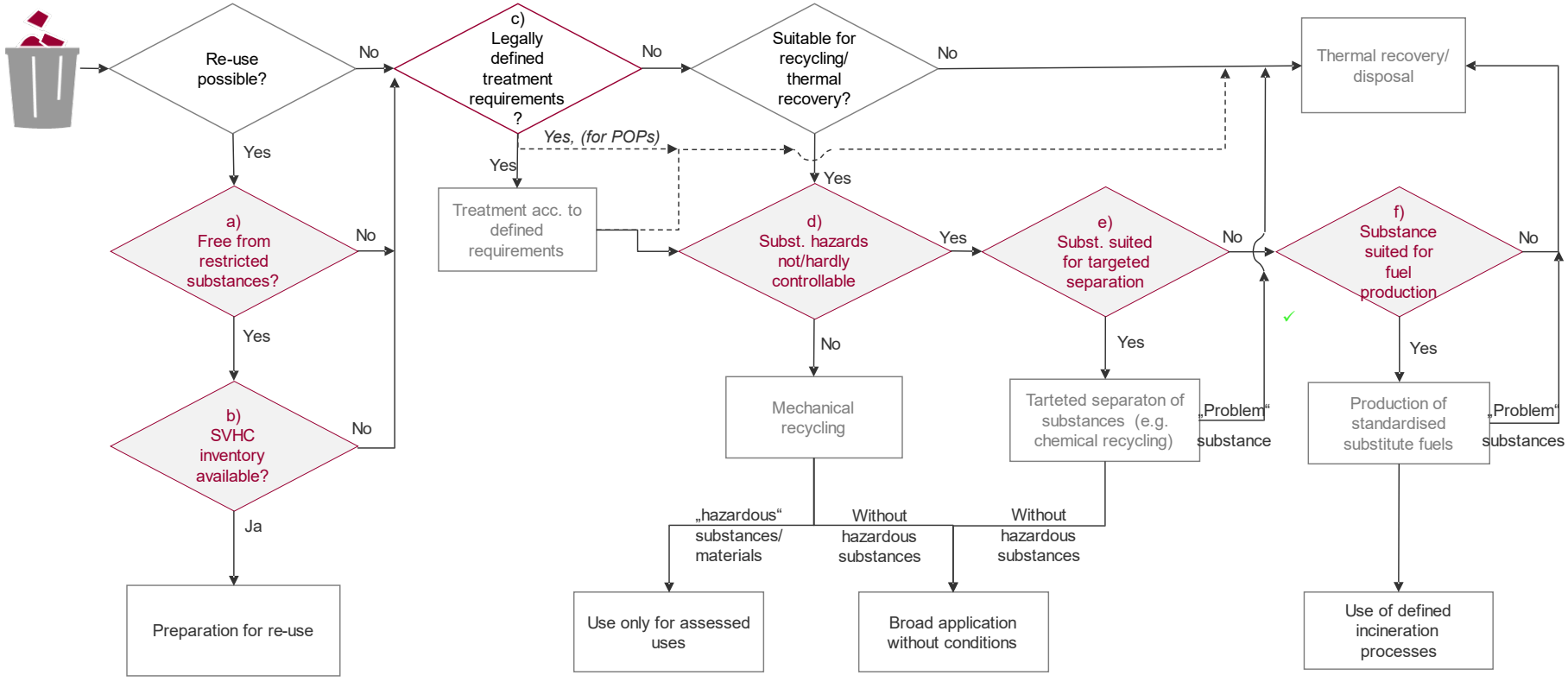
In the context of the project, the focus was on the question of the appropriate handling of pollutants (or substances with hazardous properties). For this reason, the relevant questions and decision points in the selection of suitable treatment pathways from the perspective of risk management of such "hazardous substances" are discussed in more detail below.

[121] This expert assessment was shared by the participants of the 2nd dialogue workshop, among others.

4.2.4 Pollutant-related decision points

Figure 41 shows the basic structure of a decision pathway for identifying the appropriate treatment, recycling and recovery pathways, which respects the waste hierarchy and takes into account the inventory of "hazardous ingredients". The key questions at each substance-related decision point are explained below.

Figure 41: Decision tree for the choice of appropriate disposal pathways for waste containing hazardous substances



Source: own representation, Ökopol

a) After products have been taken out of the waste stream because they are fundamentally suitable (under technical-economic considerations) for preparation for reuse, it must be checked whether they may be put back on the market in their current form.
A possible obstacle may be substances that are not (or no longer) allowed to be contained in these products due to a current[122] restriction.
If (newly) restricted substances (above possibly defined concentration limits) are contained in the products, they must be returned to the waste stream. Alternatively, in complex articles, a component that contains restricted substances can be replaced by a component that does not contain restricted substances (not shown in the diagram).

b) Before a possible preparation for reuse it must also be checked whether a complete SVHC inventory of the product is available. If (reconditioned) products are placed on the market again, it must be ensured that possible SVHC enquiries from customers can be answered according to REACH Art 33. Thus, the actors who place products back on the market have an obligation to investigate the SVHCs contained and the absence of (newly) restricted substances.
The information for this can either come from the original manufacturer/supplier of the product, from chemical analyses or in the future, if necessary, also from the SCIP database (cf. also section 3.2.1 and 3.2.4).

c) For waste that is not prepared for reuse, it must be checked whether specific (pre)treatment procedures are prescribed by law for the waste stream in question, e.g. according to the German end-of-life vehicles law or the German law on waste treatment of WEEE. In this case, these treatment steps must be carried out. If the separation of components or liquids containing substances that are to be directly destroyed (defined POPs, etc.) is planned, this requirement is implemented.
Even if no treatment processes and/or separation of components or liquids containing hazardous substances are prescribed for the respective waste stream, it must be checked whether the respective waste fractions contain substances that may not be recycled (e.g. due to a relevant restriction prohibiting reuse as secondary material). If this is the case, these must also be separated or sent separately for disposal (thermal destruction).

In the case of waste fractions that are fundamentally suitable for recycling and/or energy recovery from a technical/economic perspective, it must be examined whether they are suitable for "simple", mostly purely mechanical recycling processes without targeted material separation. This would be the case if it is known that:
a) no substances with hazardous properties are contained (e.g. waste from food packaging or waste previously approved as food contact material). In this case, mechanical recycling with subsequent wide use of the secondary materials is possible.
b) the hazardous substances contained do not have SVHC properties and the use of the secondary materials can be limited to uses where (due to the existing exposure conditions there) no risks can arise. In this case, mechanical recycling with use of the recycled materials in certain uses is possible.
If SVHC substances are present in the waste stream and/or this is not known and the use of the secondary materials cannot be controlled, mechanical recycling should not take place.

d) If "simple recycling" is not appropriate after examining the above considerations, the next step is to assess whether the waste fraction can be fed into a recycling process with targeted separation/destruction of the problematic substances. These can be recycling

[122] Logically, these can only be (new) restrictions that only became legally binding after the original (first) placing on the market.

processes with process conditions in which the substances concerned are completely destroyed without causing damage, in particular through high temperatures (metal, glass) or processes in which the pollutants/fractions containing pollutants are separated in a targeted manner.
In addition to the already established processes for the material flows metals, glass and paper, so-called "chemical recycling" is currently being discussed as a possible process with targeted pollutant removal. In chemical recycling, plastics are to be split into their monomers, purified and polymerised again. So far, there are only a few plants (mostly still pilot and test plants) that carry out these processes and it is unclear for which plastics these processes are technically and economically possible and with what effectiveness pollutants, e.g. plastic additives, are separated from the material stream. Separated pollutants would also have to be destroyed separately or, if this is possible, fed into new products as "purified" input materials.

e) If recycling with separation of pollutants is not possible, it can still be examined in the following step whether the ("remaining") waste fractions can be used for the production of standardised substitute fuels and thus for thermal recovery with a view to (also) the pollutant inventory. In the production of such standardised substitute fuel qualities, a number of material requirements usually have to be met, which result from the combustion processes and the waste gas purification technology installed there. Typical here are, for example, maximum values for the total halogen content and/or for selected heavy metal contents, but not limit values for individual constituents.

The decision path outlined above is explicitly the conceptual sequence of pollutant-related questions. In the waste management processes, the treatment paths are in many cases already largely pre-determined, mainly due to technical-economic considerations. Therefore, in practice, individual or all of these conceptual test steps are "skipped", e.g. if a waste stream with a high calorific value is intended for thermal recovery and the pollutant content is irrelevant for this.

4.2.1 Considerations on the use of recyclates

In general, 3 cases are conceivable for the use of recyclates. Secondary materials are:

- used in the same products from which they were derived (closed loop);
- used in products that have a low release potential and thus a low environmental and/or human exposure, or
- used with an unrestricted range of application.

Closed Loop

The (hazardous) substances contained in the waste can, if necessary, also perform their function again/continue to perform their function in the secondary material or product (e.g. functional additives in plastics), which can also avoid the use of corresponding (hazardous) substances from primary production. In this particular closed loop case, it may also be acceptable to recycle substances of very high concern if this use for these substances is identified in the substance registration and exposure of humans and the environment can also be safely excluded in the waste treatment. In the case of closed-loop use, the question of which substances are present in the recycled material is only relevant if additional pollutants are introduced during use that may cause risks.

Limited use in products with low exposure potential

If the waste contains hazardous substances that cannot (be) separated and properly disposed of in recycling, but (should) remain in the secondary materials, their use is only acceptable in products in which no risks can arise. In principle, a secondary material is also expected to comply with (possibly existing) material standards regarding (specifically defined) hazardous substances or substance properties.[123]

From the perspective of substance properties, risks in the use phase, i.e. due to the content of substances from recycled materials in products, are in principle possible for all substances that

- have toxic or ecotoxic but no SVHC properties and their concentration in the material is so low that exceeding the effect threshold in a use is unlikely and/or
- have effects on skin contact (especially sensitisation) and/or
- have low mobility in the material in which they are used (e.g. low vapour pressure, large molecular size, low water solubility).

If substances with such properties are present, the area of use of the secondary materials would have to be restricted accordingly (e.g. no use in products with skin contact if skin-sensitising substances are contained).

Wide, unlimited usability

Secondary materials can be freely used if they either do not contain hazardous substances or if they are only "low hazard", i.e. have local effects which, moreover, do not cause risks due to their incorporation into a product matrix. A negligible content of hazardous substances can be assumed if the secondary material is produced from waste that is known not to contain hazardous substances and/or is produced from waste that only contains hazardous substances that are separated or destroyed in the respective recycling process. For the second case, the structure and composition of the pollutants is primarily relevant (organic/inorganic, content of heavy metals and other, thermostable compounds, solubility in media with which secondary materials are purified, etc.).

Not knowing the content of hazardous substances

If the recycler does not know whether and which substances are or could be contained in his secondary materials, he must decide between the goal of increasing recycling and the goal of safe materials. As a rule, priority is given to the production of safe materials, which means that materials that could be recycled from a material point of view are not fed into the corresponding processes for precautionary reasons. In order to further exploit the recycling potentials here, for one, additional assessment tools would have to be developed for waste management that are oriented towards the methods of chemical safety assessment and are also practicable for the target group. In the long term, the aim should also be not to use substances with certain properties at all (keyword sustainable chemistry or "safe by design" approach) or to take disposal more into account already in the design of articles (extended producer responsibility).

Information sharing

For all options for the use of secondary materials, including the substances of concern they contain, in addition to limiting risks in the second use phase, it must also be clarified how information about the "accepted" presence of these substances at the end of the second life cycle

[123] Due to the composition of the waste from which the secondary materials are produced, however, the goal of achieving an "identical composition" of primary and secondary materials is neither realistic nor necessary. This goal could be achieved, if at all, in the recovery of individual materials, if a (very) high effort is made with regard to purification.

is transported to the subsequent second (and possibly further) waste phase, so that informed decisions can again be made at that point.

In this context, it seems important to define the end of waste (of recycled materials) as "early" as possible when these are (still) substances or mixtures. This would ensure that they are classified and that a safety data sheet is prepared, which can transport information on the composition (of mixtures) and hazardousness into the subsequent supply chain. From the supply chain, this information can then be passed on again to the second waste phase via appropriate communication solutions (cf. the explanations on topic 2 of the dialogue events).

4.3 Expert Dialogue 3 and its results

4.3.1 Framework conditions

The dialogue workshop 3 on the topic "Strengthening the waste hierarchy: decision support for the selection of treatment pathways" was held as a web conference on 28 September 2021 from 09:00 - 15:00.

A total of 20 people took part in this dialogue. Participants came from all affected areas of the economy and administration. In addition, representatives of consumer protection associations were also involved in this expert dialogue.

The schedule of the dialogue, the presentation slides as well as a summary of the discussins agreed upon with the participants can be viewed on the project website at **https://oekopol.de/themen/ressourcen-und-kreislaufwirtschaft/fachdialoge-abfallrecht-chemikalienrecht/.**

4.3.2 Selected discussion points

Some key points from the discussions of the dialogue workshop are reproduced below.

4.3.2.1 All levels of the waste hierarchy are relevant

During the discussions, it became clear that, from the point of view of the participants, all stages of the waste hierarchy, including disposal, are important even in a circular economy that is further expanded in the future. Some participants attributed an important "kidney function" for a functioning circular economy to (high-temperature) incineration in particular, with its ability to destroy problematic (organic) substances.

With regard to landfills, however, some participants pointed out that a landfill ban for non-pretreated waste must be enforced at EU level as an important contribution to climate protection. Representatives of the authorities pointed out that a landfill ban on plastics is already anchored in the legal text (§ 5 EU Directive 1999/31/EC on the landfill of waste), but the technical requirements for this are still missing.

4.3.2.2 Goal contradiction between "completeness" and "simplicity"

Regarding the questions on the selection of suitable treatment pathways, almost all participants in the discussion stated at least once that all decisions should be based on "comprehensive" or "360°" assessments that take into account the existing differences in waste streams in a differentiated manner.

This requirement for completeness referred to quite diverse aspects, such as the consideration of all:

- Environmental impacts (e.g. from climate impact to environmental toxicology)

- Waste streams
- Treatment and recycling options
- Patterns of use in the second life cycle
- Substance groups

At the same time, the desire for simple decision-making bases, pragmatic solutions and not too detailed regulations was expressed in many cases. The recognisable contradiction of goals was addressed, but could not be resolved.

4.3.2.3 Recycling of hazardous ingredients requires appropriate frameworks

In recycling, a distinction must be made between "closed-loop"[124] and "open-loop"[125] recycling. If substances with hazardous properties, such as functional additives, are contained in recycled materials, a safe use in the second life cycle in the "closed loop" can be reasonably assumed if the following conditions are met:

- The concentration (and the type of incorporation) of the substance in the recycled material corresponds to that in the primary functionalised material.
- The material is introduced into the secondary products under comparable process conditions and the secondary products are used in the same way as the original products (same primary and secondary use patterns and exposures).
- A risk assessment has been carried out for the hazardous substance in question in relation to the primary uses, i.e. the primary use has been identified as "safe".

Practical experience with the establishment of such closed-loop procedures shows that:

- A proper check of whether the boundary conditions of the original risk assessment fit, e.g. with regard to the use and application patterns for the secondary materials, requires stakeholders to have access to these assessments. However, the chemical safety assessments of registrants are not (currently) publicly available.
- Controlling regulations on the use of secondary materials (with certain pollutant contents) are lacking, which would ensure that secondary materials only enter areas with comparable patterns of use and application. Such regulation (restrictions with targeted exceptions) would (also) be helpful as they create a level playing field in the European market.

The Additive Sustainable Footprint (ASF)[126] developed by VinylPlus was named as an example of how the industry, together with scientists and consultants, can develop a system that also makes detailed information on hazardous ingredients available in the long term. Close cooperation between the actors in the value chain is necessary for the development and maintenance of such a specialised information system.

4.3.2.4 Design and monitoring of the framework

Both the representatives of the public administration and the market players stated that both the design and the critical monitoring of the large number of parallel processes for the legal

[124] I.e. substances are introduced into the same products in which they were previously used.

[125] I.e. substances are used in other products.

[126] Further information on the ASF: https://www.vinylplus.eu/sustainability/our-contribution-to-sustainability/additive-sustainability-footprint/

frameworks (especially in the area of chemical approvals and restrictions for individual substances) tie up a lot of resources and often exceed the available resources. This poses the risk of inconsistencies and suboptimal frameworks due to a lack of cross-coordination.

4.3.2.5 Adapted design of functional additives

Representatives of the waste management sector point out that the circular economy starts with product design; additives, especially for plastics, must be developed and formulated in such a way that they do not hinder recycling. The participants agree that closer cooperation between the actors in the waste and chemicals sectors would be helpful with regard to product design and the development of recyclable additives.

In order to increase the pace of development of such circular solutions, there is a need for increased cooperation between the actors involved as well as corresponding investments in research and development. Stable legal frameworks and thus legal certainty are an important aspect for the development and release of such necessary financial resources.

From a scientific perspective, it was mentioned that the state of knowledge about the hazardous properties of substances as well as the assessment practice of substances will continue to develop dynamically, which poses a challenge for medium and longer-term substance substitutions. The trend towards the chemical assessment of groups of substances rather than individual substances should help to avoid unfortunate substitutions and to remove entire groups of substances from material flows in the future.

5 Observations & approaches

Based on the expert dialogues, the preliminary and follow-up expert discussions with individual participants and the underlying background research from the project, the authors present some central observations and corresponding conceptual conclusions ("approaches for action") below.

5.1 Observations

5.1.1 Cross-sectoral exchange between the actors is useful and necessary

Throughout the course of the project, it became clear that there seemed to be rather few debates and consultations between primary supply chain actors and waste management actors in the past where:

- the respective applicable chemicals-related legislation, and
- the underlying conceptual considerations

have been systematically addressed. This applies equally on the part of the market actors as well as on the part of the specialised administrations.

The expert discussions held in the course of the project, on the other hand, clearly showed that mutual understanding of the details of the existing legislation in the different areas as well as the established practical handling of substances classified as hazardous is a necessary prerequisite for jointly identifying obstacles and challenges in closing material cycles and developing appropriate solutions.

A corresponding and intensive exchange as well as the development of a common conceptual understanding between all responsible actors are of fundamental importance according to the assessment of those involved. This is also due to the fact that waste management must take on a rethought role in a functioning circular economy.

In the circular economy, the waste management processes are increasingly understood by the market actors as secondary supply chains and no longer, as in the past, primarily as downstream solutions for harmless disposal. As a result, the target qualities of the treatment and recycling processes and the corresponding quality assurance and communication routines are also taking on a new significance.

5.1.2 Change in the importance of optimisation approaches

The new/additional function of waste management as a "secondary" supply chain is also accompanied by a change in the direction of optimisation considerations.

This concerns two areas:

- the control of the treatment chains and
- the influence on the primary manufacturing processes.

In line with the understanding as a supply chain, the waste treatment chains must primarily[127] be geared towards producing recycling materials that meet clearly defined quality requirements in order to generate and serve a correspondingly broad market demand. In addition to the

[127] In contrast, in the past the focus was more on disposing of or recycling incoming waste as cost-effectively and harmlessly as possible. Markets were sought and/or created for resulting recycling materials in the "emerging" quality.

chemical-related quality discussed in the expert dialogues, this also applies to the other technical parameters of the secondary materials.

Also following the changed basic understanding, the products/articles on the market are understood as (future) resources within the scope of circular economy. This means that the (eco)design of primary product manufacturing is of central importance. Whereas from the point of view of waste management it has so far been primarily a matter of specifically excluding problematic materials (which can disrupt waste management processes in a particular way)[128] or simply making them separable. Now the question arises as to how entire collection fractions can be made recyclable[129]. Among the approaches discussed is a reduction in the material diversity of products that end up in the same waste collection fractions. For example, the types of plastics (in terms of basic polymers) and/or their additives in electronic devices (in terms of the substances they contain) could be limited. On a more specific level, it is also discussed here to standardise the functionalising additives and thus reduce the diversity of the inventory of hazardous substances in the collection fractions[130].

5.1.3 Detailed aspects

5.1.3.1 Standards for recycled materials are often inadequate with regard to pollutant content

Quality standards for secondary materials are recognised as an important element in a future circular economy, because standardised material qualities are a prerequisite for many product manufacturers to use the relevant quantities of recyclates.

However, the corresponding existing standards for recycling materials currently only partially contain maximum limits for selected hazardous substances beyond the specification of technical properties, mostly in the form of sum parameters (e.g. total halogen content or similar). These limits often "merely" represent the pollutant-related quality that is achieved when using the currently typical collection fractions after passing through the established recycling processes. As a result, frequently primarily recyclate qualities are standardised, the material composition of which does not result in a designation as a "hazardous mixture".

In contrast, the standards do not contain further information on "safe conditions of use" and/or requirements for individual ingredients and/or their specific exclusion. In addition, recyclate standards are currently mostly formulated on a sectoral basis, i.e. oriented towards the "closed loop idea".

According to the assessment of some people who participated in the dialogue process, it can be simplified to say that the standards for secondary materials have so far been formulated predominantly "origin-related". For the circular economy, however, it would be important (in accordance with the image of the secondary supply chain) that, on the one hand, even more standards are developed for market-relevant secondary materials[131] and that, on the other hand,

[128] The RoHS Directive (2011/65/EU) with its substance restrictions is an example of such a protective regulation developed from waste management.

[129] In the context of the implementation of the EU Ecodesign Directive (2009/125/EC), it is currently being discussed how far-reaching requirements for recyclability can be established "across" a larger number of product groups by means of horizontal implementation measures.

[130] This way of influencing the inventory of pollutants in product design is an original aspect of waste prevention according to Art. 3 para. 12 of the WFD and § 3 para. 20 of the KrWG. However, they have hardly been taken into account so far in the waste prevention programme of the Federal Government and the Länder and in the corresponding implementation measures. Furthermore, this approach is also supported by the activities in the field of the Chemicals Strategy for Sustainability, which is currently still under discussion. This provides for limiting the use of the "most harmful substances" to areas that are essential for society in terms of health and the environment as well as critical fields for the functioning of society.

[131] Currently, for example, wood-based materials can contain any waste wood according to the European product standard without the waste wood being defined at all. A recycled wood standard for use in wood-based materials would be a manageable solution.

these standards are developed "use-related", i.e. oriented to the material (target) quality required for the products.

5.1.3.2 Uniform determination of the end of waste

Apart from a few exceptions[132] , there is no uniform specification of the end of waste properties for most waste streams. Particularly with regard to the handling of hazardous substances, this sometimes leads to inconsistent situations.

There is a tendency to release waste material streams from the waste regime at an early stage where the content of hazardous substances is below the limits of the CLP Regulation, i.e. no classification or labelling of the secondary material as "hazardous" is required under chemicals legislation. If, on the other hand, higher proportions of hazardous substances are contained, (secondary) articles are often still produced in the waste regime[133] and only these are placed back on the market as non-waste or products.

Especially the latter case is problematic from the perspective of transparency and risk control of hazardous substances in the circular economy. As there are neither identification nor declaration obligations for hazardous ingredients (apart from SVHCs) for articles in product or chemicals legislation, the corresponding information is missing for the further use phase as well as for an upcoming waste phase.

5.1.3.3 Waste classification: clarifying the function and strengthening consistency

In the first expert dialogue it became clear that the majority of wastes that used to be articles are classified on the basis of their origin. As a rule, these former products are classified as absolute hazardous/non-hazardous, i.e. mirror entries hardly occur with these wastes. Against this background, the major challenges posed by the dynamics of CLP implementation for waste management formulated by some market actors are significantly mitigated.[134]

In the case of waste types that are listed as mirror entries in the waste list[135], deviations from the classification as "hazardous" required according to the hazardous substances content are found more frequently in practice[136]. In the opinion of the authors of this report, these are often procedures that have been established for years without these classifications being regularly reviewed on the basis of the specific chemicals content of the respective waste. A stringent implementation of the legal requirements would at least partially result in the classification of previously non-hazardous waste as hazardous waste. In some areas, this would probably lead to far-reaching problems, since, for example, the majority of existing facilities for recycling plastics from the construction sector do not have a permit to accept "hazardous waste".

In practice, the primary function of waste classification is in fact ("still") to trigger or indicate a "special need for monitoring"[137] of certain (industrial/mass) wastes and to enable a controlling intervention by the authorities in terms of allocation to a suitable treatment facility.

[132] At the EU level, corresponding regulations specifying the end of waste have so far only been issued for aluminium, steel and iron scrap, glass cullet and copper scrap.

[133] An example is sealing membranes for the construction sector, which are produced from PVC flooring waste within the waste phase and which naturally (continue to) contain the corresponding plasticisers, which are predominantly classified as "hazardous".

[134] For example, the currently much-discussed amended CLP classification of titanium dioxide, despite its use in plastic products, only results in the need for reclassification for plastic waste from the construction sector under certain conditions.

[135] This applies in the area of product-specific waste types, e.g. for wastes from the construction sector "Chapter 17" with regard to the mirror entries 17 02 04* or 17 09 03*.

[136] Discussed in the dialogues for the example of lead-containing old window profiles.

[137] This was the "old" term under waste law, which was used for what is now "hazardous waste" until the amendment of the Act to Promote Closed Substance Cycle Waste Management and Ensure Environmentally Compatible Waste Disposal (KrW-(AbfG)) in 2006.

The classification of a waste as "hazardous", on the other hand, has no direct legal consequences, e.g. with regard to concrete risk management measures in the various treatment processes. In practice, however, it can be observed that a "hazardous waste" designation also has consequences in the handling of the material and, among other things, triggers further testing steps. For example, the ingredients in "hazardous" waste are more likely to be taken into account in occupational safety-related risk assessments (presumption of a hazardous substance in the sense of the German Hazardous Substances Ordinance) than when only "non-hazardous waste" is handled. However, these are only indirect legal consequences and not direct ones. In fact, due to its purely "dual character", the classification is also not at all suitable for "transporting" concrete risk information and thus triggering concrete, appropriate protective measures.

Against the background of the discussions in the expert dialogue outlined here, the authors of the report come to the conclusion that it might make sense to once again bring about a fundamental clarification of the function of waste classification from the perspective of "material flow control versus risk communication".

5.1.3.4 Recycling of functional ingredients as an additional challenge

The basic approach of waste legislation that substances with hazardous properties contained in waste are to be separated and destroyed as a matter of priority during waste treatment, is increasingly being questioned with regard to functionalising additives for some technical materials.[138]

The properties of most materials used in today's manufacturing processes are modified ("functionalised") by adding special additives or alloys so that they meet the functional requirements of the respective end products.

Some of these additives/alloys (also) have hazardous properties (e.g. flame retardants or plasticisers etc.). If these substances are used in the applications identified as having "safe use" conditions in a risk assessment carried out by the distributors (as part of the registration under REACH), it can be assumed that possible risks further down the life cycle are controlled and thus limited. Nevertheless, the hazardous property of these additives remains and is accepted in the product, as the risk control seems to be given in the use phase. In this context, the subsequent waste phase or a 2nd life cycle are currently still considered rather subordinate in the registration process under REACH.

The environmental rationality of separating and destroying these substances, which can be costly and is usually also associated with a loss of basic material, is difficult to convey. This is especially the case if similar substances have to be added again immediately after the end of waste[139] in order to ensure the necessary functionalities.

This results in the need to be able to recycle technical materials independently of the hazard profile of their ingredients. It is undisputed that reuse can then only take place within the framework of "safe uses".

Even if there are intensive efforts to achieve these functionalisations in the future without substances with hazardous properties, most market players believe that this conversion process will still take many years in a number of application areas (if complete substitutions are possible at all). However, there is also a controversial discussion about the extent to which the targeted

[138] These discussions are being held in the field of plastics recycling in particular, as here the broad possibilities of functionalising the basic material play a very large role in their technical application.

[139] Especially as these materials often weigh 1-2 orders of magnitude more than the basic materials in terms of their production costs and thus also their ecological "weight".

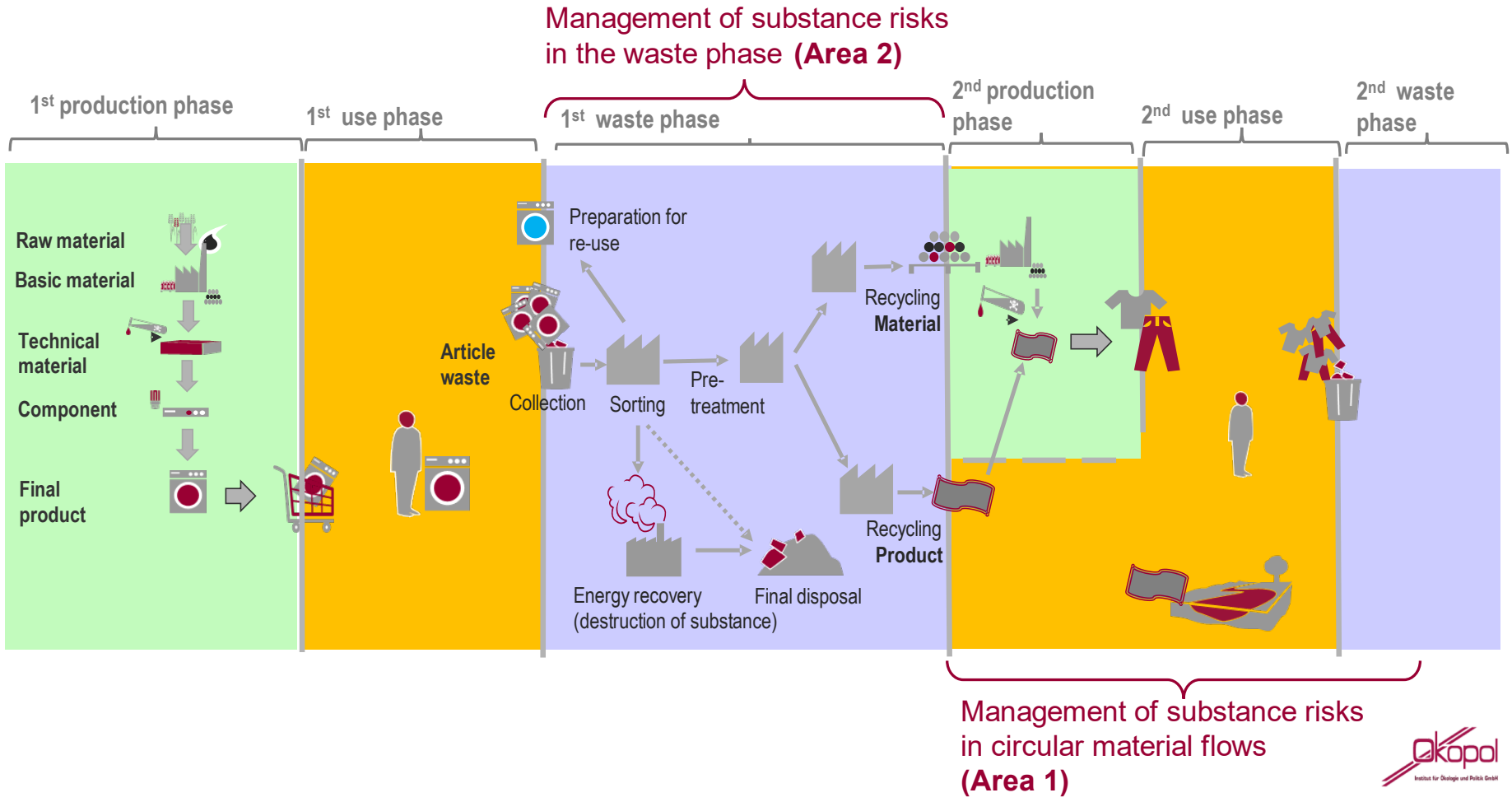
recycling of hazardous additives also delays or even blocks substitution developments. Various instruments are currently being discussed in the field of chemicals policy. On the one hand, substitution could be promoted more economically or the pressure on market actors should be increased so that they are forced to use alternatives as far as possible. A balance must be found here between recycling on the one hand and substitution efforts on the other (e.g. through separate material flows in transition).

5.1.4 Two central areas of discussion of existing problems and possible optimisations

During the project work, it became clear that with regard to the interfaces between chemicals legislation and waste legislation, there are in fact two different areas to be discussed in which a need for action can be identified.

These are, on the one hand, the management and control of material risks that (can) arise during the recycling of (waste) material flows in relation to "putting them back into circulation". On the other hand, it is the management of material-related risks within the waste phase. The following figure shows these two areas.

Figure 42: Schematic allocation of the two areas of action to phases in the life cycle



Source: own representation, Ökopol

Area 1: Control of material risks during the recycling process

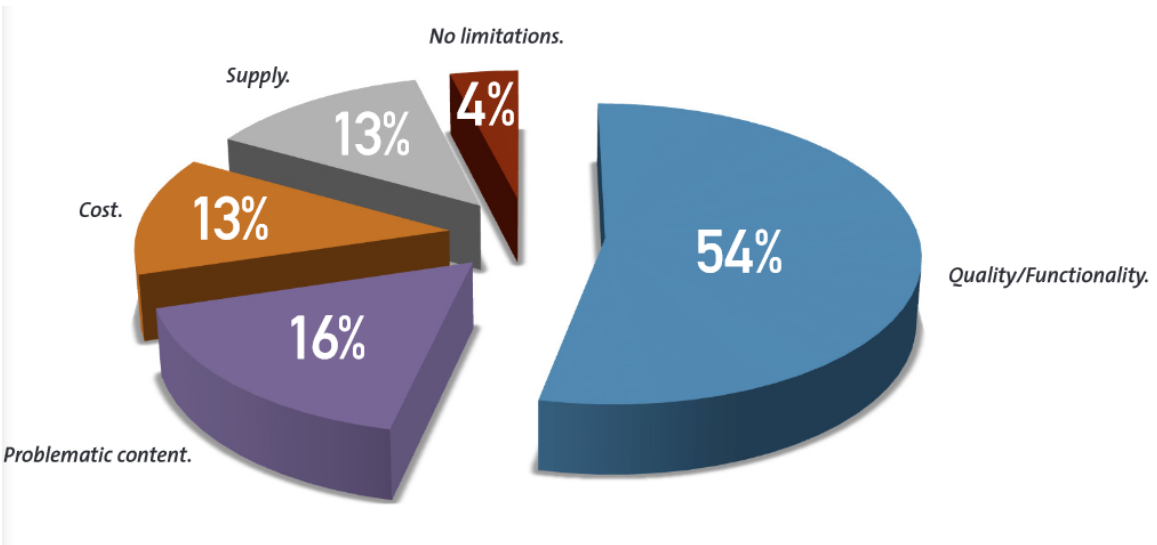
In the project discussions, the following challenges were identified with regard to the control of substance-related risks in circular material flows[140]:

- One the one hand, relevant quantities of collected waste materials are currently sent "across the board" to energy recovery or recovery as substitute fuel and not to recycling because it is known that they contain or may contain substances with hazardous properties. The main reason for this situation is that the waste actors can neither identify the contaminated fractions nor separate them in a meaningful way.
- On the other hand, relevant quantities of hazardous (ingredients) substances below the thresholds of the CLP regulation are placed back on the market in the form of recycled materials or articles, without some of the actors responsible for placing them on the market having systematic knowledge of this contamination.

The second point is known to market actors and contributes to a clear reluctance of many product producers to significantly expand the use of recyclates in their products. The implementation of quality standards for secondary materials can improve the situation here. However, the confidence of the users of recycled materials is also an important point, which contributes to the reluctance to use recycled materials due to the often low willingness of recyclers to provide information on chemicals[141] in their materials to the supply chains.

In this context, the graph below uses the example of plastic recyclates to show the high importance of the aspect of "problematic content" in relation to the decisions of product manufacturers for or against secondary materials. It comes from a recent study by ChemSec, in which EU-wide companies were surveyed with regard to obstacles in the use of recyclates.

Figure 43: Reservations (proportionate) of companies against the use of plastic recyclates



Source: ChemSec 04/2022[142], Figure 3

[140] Also the here documented observations and conclusions mainly relate to plastic wastes as they were in the main focus of the debates. According to the authors of this studies, many of these can be transferred to other waste streams.

[141] Partly due to a lack of knowledge about the pollutant content, but also for reasons of a certain bias, so as not to portray one's own materials badly, which ultimately only leads to a lack of transparency that deprives potential users of recycled materials of the opportunity to act in an informed manner and assess their product-specific risks.

[142] ChemSec „Not quite 100% - The importance of Transparency in Non-Mechanical Recycling", April 2022, unter https://chemsec.org/app/uploads/2022/04/Not_quite_100_percent.pdf

Establishment of standard-compliant quality assurance routines and documentation

To establish a real, quantitative implementation of the circular economy, the improvement of (chemical) product quality is urgently needed. Since the (residual) contents of hazardous ingredients in secondary materials are usually unknown, they are widely applied and in different products. Especially in the case of stable (persistent) and bioaccumulative substances, this can lead to negative environmental impacts if there are uncontrolled inputs into the environment in the further life cycle of the various products. [143]

The challenges with regard to obtaining information on the content of hazardous substances in waste and the goal of manufacturing pollutant-free products from recycled materials, which result from such non-traceable carry-over of problematic substances into the broad product world and its subsequent waste phases, as well as from the intended multiple recycling, can hardly be solved from a systematic perspective.

Area 2: Management of material risks within the waste phase

With regard to the management of material risks within the waste phase, the following key conclusions were drawn:

- In the case of (bulk) waste from industrial and commercial production, there is often direct contact between waste producers and waste disposers and thus usually also a functioning exchange of information on hazardous ingredients. In combination with a corresponding network of relevant protective regulations, it can be assumed that an informed and comparatively well-balanced risk management system is established here.
- In contrast, there is no direct contact between waste producers and waste disposers in the case of waste from articles. Information flows are systematically interrupted by both the article status[144] and the service life. In addition, waste management actors have very limited specific data on hazardous ingredients and their associated hazardous properties. In combination with the significantly less systematically elaborated requirements for waste classification, as well as partly missing/insufficient activities on the part of the responsible enforcement bodies[145], this probably leads overall to both over-conservative and incomplete decisions regarding the necessary risk management measures.

5.2 Identified courses of actions

On the basis of the above observations and conceptual assessments of the authors[146], at least for the waste in the focus of the project, a set of concrete starting points can be named for each of the two areas of action (1 waste phase & 2 recycling), where the management of material risks could be substantially improved and recycling strengthened through voluntary activities of the market actors or the change of regulatory requirements. [147]

[143] In addition, the composition of the waste stream can fluctuate significantly in some cases. This means that a lack of control of the pollutant content can repeatedly lead to individual legal limits being exceeded, which can result in the purchaser of the recyclates failing to comply with legal standards (e.g. in the context of REACH, packaging legislation, soil protection, etc.).

[144] I.e. the significantly reduced information requirements in chemicals legislation on ingredients with hazardous properties in articles.

[145] Examples of such enforcement deficits are the feeding of waste with hazardous substances (resulting from incorrect waste classifications) to treatment facilities without a corresponding permit or the non-implementation of the SVHC-related information requirements of REACH Article 33 for products after "preparation for re-use" has been completed.

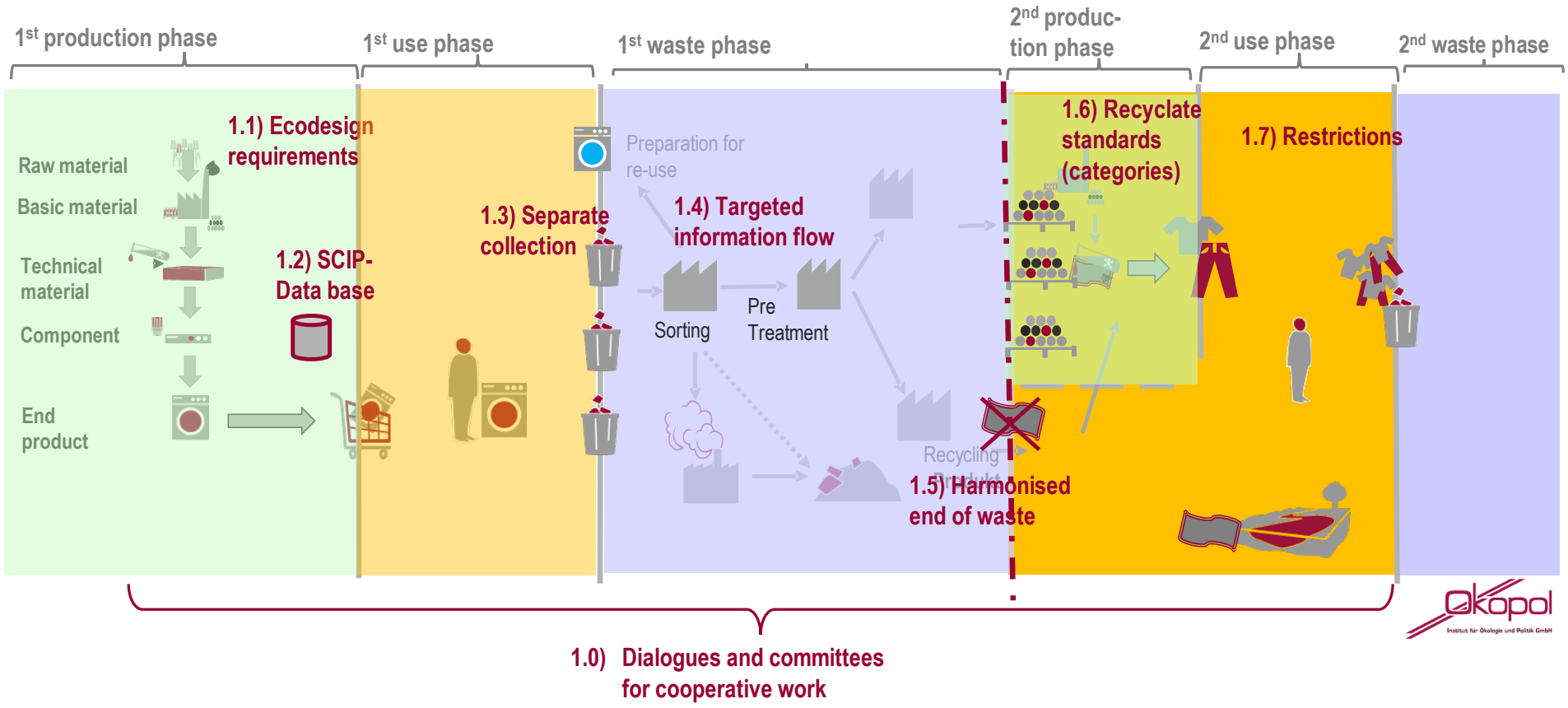
[146] The following explanations are based on a more comprehensive internal concept of the Ökopol Institute on the possibilities and limits of the circular economy.

[147] These proposals for action explicitly go beyond the tendential consensus that could be found in the debates with the participants in the expert dialogues.

5.2.1 Improvements in the control of material risks during the recycling process

To systematically improve the control of material risks in recycling and to strengthen the confidence of market actors in the quality of recycled materials, coordinated approaches for action are suitable that target various points in the recurring life cycle of substances, materials and products. The following figure first shows an overview of eight relevant approaches to action, which are then briefly explained in the following sections.

Figure 44: Starting points for improving risk management in circular material flows



Source: own representation, Ökopol

5.2.1.1 Starting point 1.1: Establish dialogues and working bodies for the coordination and cooperation of all actors in the recycling of technical materials

5.2.1.1.1 Content:

In order to achieve the overarching objective of establishing "safe" and at the same time quantitatively relevant and thus resource-saving circular material flows that contain or may contain hazardous substances, it appears necessary that a systematic exchange of information and binding cooperation between all market actors who "manage" the respective materials throughout their entire life cycle take place to a much greater extent than has been the case to date.

From the authors' point of view, it is appropriate if the different (technical) materials form the constitutive element for such interaction. Because at its core, the circular economy is always primarily about the circular use of such technical materials and much less about the recycling of entire articles from the most diverse product sectors[148]. This proposal for action thus differs significantly from the more product-group or sector-specific discussion and work structures on the circular economy within individual economic sectors (such as EEE, automotive, etc.) that are frequently found at present.

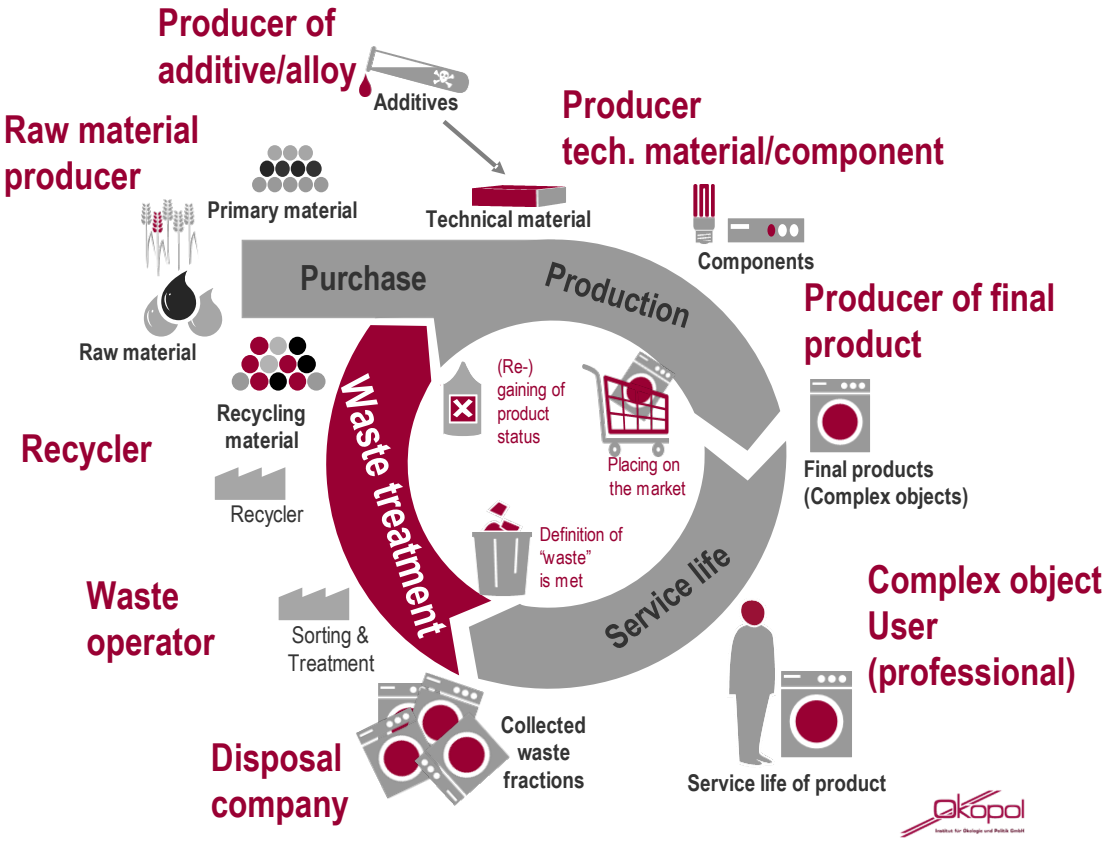
It is important that all actors who influence the material composition of the respective material flow are involved in such a cooperative interaction, i.e.

- The manufacturers of the basic materials
- The manufacturers/suppliers of additives, alloys and mixtures for functionalising the materials
- The manufacturers of the technical materials/precursors
- The producers of the final articles, which are subsequently placed on the market for use
- The (commercial) product users (insofar as significant inputs of hazardous substances into the material occur in the course of use)
- The waste collectors
- The operators of sorting and pre-treatment facilities
- The operators of recycling plants
- The (re-)users of secondary materials
- Other actors, e.g. environmental and consumer associations, (application-related) science, experts/certifiers (not exhaustive)

The following figure shows this "necessary" participation of economic actors again in a graphical overview.

[148] This applies regardless of the fact that approaches to strengthen the waste-prevention concepts of repeated repair and refurbishing of complex products in the context of resource conservation are undoubtedly justified and important.

Figure 45: Actors involved in the management of technical materials in the circular economy



Source: own representation, Ökopol

5.2.1.1.2 Function

Only in close cooperation between the various actors along the entire life cycle of products can the specific design of measures for the respective material flow be discussed and agreed upon, which will further concretise the approaches for action outlined below and make them effective.

It is necessary that all these market players make a clear commitment to the overarching goal of realising an increase in the "safer" use of secondary materials. This also includes the willingness to examine and, if necessary, implement substantial changes to existing material and product designs, existing business models and technical processes.

5.2.1.1.3 Implementation

Challenges in initiating such circular cooperations and the joint implementation of ingredient control measures are that, unlike in primary, "linear" supply chains, there are no clearly defined "system leaders" in the circular economy and that the economic interests and opportunities in the circular models have so far been quite unequal in some cases.

Against this background, it could be relevant to examine in an open-ended manner whether the introduction of a legally anchored system of extended material responsibility[149] for the primary

[149] Analogue to existing systems of extended product responsibility or also as a concretisation of a "product responsibility for certain preliminary products" for technical materials. According to the authors, material responsibility would make it possible to address many questions of material quality (including chemical content) and the recycling of materials in a very targeted and appropriate manner. With a view to such a new regulatory approach, however, a large number of fundamental questions (such as an exact definition of the term "material") would naturally have to be discussed and clarified. Unfortunately, this is beyond the scope of the present report.

material producers (in the sense of responsibility for the most resource-efficient management possible of the entire material pool) would possibly lead to structures between the market actors that are more effective.

5.2.1.2 Starting point 1.2: Binding, substance-related ecodesign Requirements

Content:

Within the framework of binding ecodesign specifications, the (composition of the) basic materials and in particular their functionalisations are harmonised in each case for those articles that are collected and treated together again as waste after their use phase.

Function:

The harmonisation of the material composition of the products aims, on the one hand, to promote the substitution of "hazardous" ingredients and, on the other hand, to be able to either separate the (basic) materials collected together for disposal well during subsequent waste treatment or to recycle them together in a high-quality manner.

In the context of this report, the focus is on the former aspect. As an (intermediate) step on the way to the most complete possible substitution of all hazardous ingredients, the number of hazardous substances that, according to the state of the art, cannot be dispensed with because they are necessary for the functionality of the products should first be reduced as much as possible. This also means that the number of substances that can be used for the same functional purpose should be limited.[150] In fact, such a procedure would also correspond to the "essential use concept" discussed within the framework of the chemicals strategy, according to which hazardous substances should only be used, taking into account necessary risk reduction measures, where this is absolutely necessary for society to function or where no suitable alternatives are demonstrably available.

The result of such activities would be a "limited" list ("positive list") of hazardous ingredients that can be expected in a collection fraction of end-of-life products jointly collected for waste disposal. With a view to such reduced "pollutant lists"[151], it would then also appear quite feasible that both efficient and effective information flows to the actors in waste management are established and targeted testing and quality assurance strategies for secondary materials are developed (cf. also starting points 1.5 and 1.6).

Implementation:

In principle, the requirements can be implemented very well within the framework of the (future) EU Ecodesign Regulation[152].[153] The structure of the derivation and negotiation processes of this regulation takes particularly strong account of the "functional" differences and special features of individual product groups in a larger product segment. Furthermore, this regulatory instrument can be used to address a particularly wide range of different products, as the EU Ecodesign Regulation is to be extended to other, non-energy-related product groups

[150] The final choice should lead to the least dangerous alternatives. And this should be done even if this may lead to a slightly higher consumption of an additive or justifiable additional costs.

[151] In fact, these would be lists of the permissible hazardous substances in the various materials of the products of an individual product group. The synopsis of these "individual lists" for all product groups usually included together in a collection fraction then logically results in the overall list of potentially expected pollutants. This shows the close interplay between this approach and the other approaches, such as Approach 1.4, which aims at an (even) stronger consideration of the hazardous substance inventory when deciding on the requirements for separate or joint collection of different product groups.

[152] https://ec.europa.eu/environment/publications/proposal-ecodesign-sustainable-products-regulation_en

[153] This is (also) an implementation of the pollutant-related aspects of waste prevention according to Art. 3 para. 12 WFD and § 3 para. 20 KrWG.

(such as textiles or construction products), according to the current status of the ongoing consultations.

In addition, it is also conceivable to implement the outlined requirements in other regulations on extended producer responsibility, at least to the extent that the corresponding legal regulations allow substance exclusions to be established (only) with the aim of strengthening the circular economy in the future.

Excursus: Criteria for Safe and Sustainable by Design (SSbD) Chemicals and Materials

In the context of the EU Chemicals Strategy, a methodological approach for establishing criteria is to be developed to support stakeholders in the SSbD assessment of their chemicals and materials. The EU Joint Research Centre (JRC) is leading this work and presented a first draft of methodology, possible criteria and indicators and the linkage of the areas to be assessed in March 2022. Following a review of practical examples, the JRC's approach will be used in particular in the research context.

The SSbD assessment is intended to cover the entire life cycle, i.e. also the application of substances in articles and complex products as well as their waste phase. However, the criteria are not to be applied directly to articles, but only to substances, mixtures and materials. How the waste phase and recycling of products will be considered in this context is not foreseeable at the time of finalising this report.

5.2.1.3 Starting point 1.3: Expanding the information content of the SCIP database

Content:

The requirements for the content of the messages to the SCIP database should be specifically expanded.

As a first step, the following information requirements should be included at least for a selection of "articles suitable for re-use"[154]:

- During the normal service life of an article, the SVHC information is regularly updated by the person placing the article on the market when new SVHCs are added to the candidate list under REACH. In addition, substances in the article have to be (post-) notified to the SCIP database for which a post-market restriction on use in that article or a material in that article has been adopted.
- In a second step, the "yes/no logic" currently implemented in the SCIP database (SVHC content in the article is less than or greater than 0.1 wt.%) should be replaced by a requirement to add the percentage of substances (SVHC or restricted substances) in the respective materials of the articles or components[155].

Function:

The information on the (particularly) hazardous substances available after the implementation of the first step enables the actors involved in the preparation for reuse to fulfil their legal

[154] Preparation for reuse" is, at least currently, only relevant for higher-value consumer goods with a longer service life (such as furniture, garden and household equipment, possibly higher-priced sports equipment, etc.). This could be the focus (initially) of a staged implementation of the additional requirements.

[155] The reference to the "homogeneous base material" is important because in subsequent waste treatment steps the product reference is regularly dissolved (by shredding, crushing, etc.) and more or less "homogeneous materials" are recycled.

obligations to comply with chemicals legislation requirements (SVHC information obligation and compliance with existing restrictions) in a comprehensive and fact-based manner.

In the second step, the SCIP database also acquires an additional significance for the actors who, in the context of dismantling or separation measures, want to/have to specifically influence the hazardous chemicals content of the respective waste streams, which are essentially composed of formerly (complex) articles.

This quantitative information would also be very helpful for the conceptual planning of targeted sorting and treatment processes in the further steps of material recycling as well as for the design of quality assurance routines for the recyclates produced. For both approaches, however, it would be helpful if the possibilities for querying average contents across specific article types ("product groups") and types of technical materials in the SCIP database were also significantly further strengthened.

Implementation:

According to the experts, Article 9 (2) of the WFD and the corresponding regulations in the Member States need to be revised in order to implement this.

The implementation would also have to take into account the relationship of the SCIP database to other data sets of the currently discussed "Digital Product Passport" within the framework of the "Sustainable Products Initiative".

5.2.1.4 Starting point 1.4: Recycling-related separate collection

Content:

Based on the recycling targets and in the sense of (also) materially defined target qualities of recycling (cf. starting point 1.6), the waste collection structures must also be reviewed to see if and where it is possible to more consistently collect "similar" articles based on their basic material structure and the hazardous material inventory[156]. For this purpose, a systematic review of the relevant requirements for the separate collection of different article groups at the end of their service life makes sense. Opening clauses in relation to existing separation obligations[157] should also be regularly reviewed accordingly.

Function:

Through the extended separate collection, specific waste streams are formed that can be treated and recycled in a technically and economically very efficient and effective manner[158].

More important for the economic viability and effectiveness are the links with the measures in starting point 1.1 ("material-related ecodesign requirements"), starting point 1.2 ("expansion of the information content of the SCIP database") and starting point 1.6 (clearly "defined recycling targets by means of standards").

[156] This concerns, on the one hand, the question of whether and how separate collection obligations should be anchored for further product/waste streams (e.g. in the course of the discussion on extended producer responsibility for textiles) and, on the other hand, the question of how the aspect of a more harmonised inventory of hazardous substances should be weighed against other waste management requirements (such as the collection of comparably sized appliances) in the regular review of existing obligations for separate collection, e.g. the collection categories for WEEE.

[157] Thus, there is naturally a contradiction between the possibilities of "overriding" the basic separation obligations of the Commercial Waste Ordinance on the basis of technical and economic reasonableness and the goal of differentiated collection of various basic materials and also pollutant classes. From the perspective of dealing with hazardous substances and with a view to the goal of a circular economy, the need for readjustments should be regularly examined.

[158] Experience from existing downstream sorting of mixed waste (e.g. commercial waste sorting) shows very clearly that in this way all access to information on the pollutant inventory is lost.

Implementation:

The intended restructuring of waste collection is very closely linked to the ecodesign measures to strengthen the "material comparability" of article groups, but also to the structuring of secondary material pools (in the context of the recyclate standards). Therefore, an implementation via the systems of product and producer responsibility seems to be particularly target-oriented.

5.2.1.5 Starting point 1.5: Support targeted information flows

Content:

In the context of the overall approach outlined here, easily readable and quickly interpretable information on material and pollutant classes of the waste is needed for the sorting processes within the waste treatment cascades. As this mainly involves very simple (aggregated) information (e.g. characterising pollutant contained? Yes/No), directly readable tags and markers/tracers can be used for transmission. Especially with regard to practical marker/tracer solutions, there is still a relevant need for development that should be specifically promoted.[159]

In the treatment cascade of articles that have become waste, more comprehensive information (types of equipment, repair instructions, etc.) on individual "non-destroyed" articles is only needed up to the process step in which the decision "pre-treatment for reuse" or "treatment for further recovery" is made. Labels that allow a link to product databases (incl. SCIP database) can also be very helpful here.

Function:

Information that supports sorting decisions and processes, e.g. by allowing easy allocation of (waste) material streams to material and pollutant classes, can facilitate the generation of desired target qualities of recycling in terms of recyclate standards and secondary material pools.

The selection of sorting-relevant information depends on the implementation of the requirements for ecodesign (starting point 1.1), for the structures for separate collection (starting point 1.3) and for the recyclate categories (starting point 1.6).

Implementation:

Since the flow of information or the labelling of products and materials must already take place in the manufacturing process, it is necessary to implement the corresponding requirements within the process of developing ecodesign requirements or in the design of product/producer responsibility systems.

Waste sorting experts should be involved in these processes.

5.2.1.6 Starting point 1.6: Uniform and binding definition of the end of waste

Content:

Since the general end-of-waste requirements of Article 5(1) KrWG are not currently being applied with regard to the hazardous constituents contained, binding end-of-waste specifications should be issued for all waste/secondary material streams in accordance with the requirements of Article 5(2) KrWG.

In order to make it possible in the subsequent second product cycle with regard to effective regulations on classification and labelling, on the dissemination of substance-related

[159] The currently frequently discussed "blockchain" based systems for a "full material declaration", on the other hand, do not appear to be very helpful in supporting material recycling processes, even in the long term.

information and to take account of restrictions on use in product and chemical legislation, the end of waste must always be defined in such a way that the products are still subject to chemical legislation, i.e. they are not yet articles.

In implementation of the requirements of Article 5 (2) KrWG, the end of waste status is to be linked to the completion of specific, completed treatment steps.

In particular, these can and should also be quality assurance steps. Quality assurance routines that allow efficient compliance with the (pollutant-related) target qualities (cf. starting point 1.6) are of particular importance if (substances) mixtures are to be released from the waste regime.

The requirements for the definition of pollutant limit values and the material composition must correspond with the corresponding classifications and specifications of the secondary material standards (starting point 1.6).[160]

Function:

A binding determination of the end of waste

- defines a clear transition point between waste legislation and chemicals legislation. This limits the current "grey areas" in the enforcement of both regulatory systems,
- creates a "level playing field" between the suppliers of recyclates,
- makes it possible to define clear requirements for the material-related quality assurance processes and to establish a clear and binding link with the secondary material standards (starting point 6).

Implementation:

The implementation can take place within the framework of the ordinance authorisation of § 5 para. 2 KrWG. In the interest of harmonisation in the internal market and in order to broadly extend the intended protective shield against uncontrolled pollutant carry-over, efforts should be made to ensure that the provisions on the end of waste in Article 6 of the WFD are as comparable as possible and valid throughout the EU. This should be accompanied by sufficient differentiation with regard to the diversity of materials and the associated recycling requirements.[161]

5.2.1.7 Starting point 1.7: Development of overarching pollutant-related recyclate standards for defined use categories

Content:

To support closed-loop recycling, standards for secondary materials (or recyclates) must be developed that contain clear requirements for the permissible inventory of (hazardous) ingredients for the correspondingly defined (secondary) use categories.

In the case of (secondary) materials that are completely free of ingredients with hazardous properties, the range of possible uses is "only" limited by the technical properties.

[160] And thus, only indirectly with "standards for products"", to which § 5 para. 2 item 3 refers.

[161] This is mainly aimed at the observations from the EU process to define end-of-waste criteria for plastics. In this process it became clear that for large heterogeneous groups of materials a "one fits all" approach cannot lead to desired results and harmonisation of the approach.

In the case of secondary materials containing hazardous ingredients[162], on the other hand, the conditions of use under which the material can be used safely must be examined. They should be the result of a systematic risk assessment and should be described in concrete terms.

For standardisation purposes, it can be very useful to address different "use classes" with different sub-standards. Such use classes differ with regard to the hazardous substances by the type of the respective permitted inventory of hazardous substances as well as the respective exposure conditions in the 2nd life cycle of the material. I.e. materials with very low contents of hazardous substances can be applied quite broadly ("approved") for uses in quite diverse areas[163]. Secondary materials with higher levels of hazardous substances (but below legal limits), on the other hand, should only be allowed to be used, for example, in applications where there is no direct contact between the user and the materials and consequently a low risk of exposure.

The conditions of safe use in the respective use classes would have to be described in concrete terms in the standards. If the system of use description based on "use descriptors", which is also established for chemical safety assessment under REACH, is used for this purpose, this information can be directly linked to the usual risk management processes established in the primary supply and manufacturing chains, at least in a first iteration step.[164]

It can also be helpful to supplement the use classes with additional (exemplary) information on "suitable target products". This makes it easy to understand, even for less technically experienced market players, whether the possible inventory of hazardous ingredients of a secondary material is permitted for use in a product area or not.

Function:

Appropriate standards for secondary materials, even more clearly defined in terms of pollutant content, will give the upstream processes of waste management (as a secondary supply chain) and their information and quality assurance routines clear quality targets to which they can be aligned. Moreover, such secondary material standards, which:

- list clear, possibly tiered, requirements for (hazardous) ingredients,
- also contain technical descriptions of how valid quality assurance routines can be established through appropriate sampling and analyses (cf. also starting point 1.5) and
- combine compliance with these requirements with the possibility to use the materials safely under defined conditions of use (or "use classes")

provide product manufacturers with a substantial basis for deciding on the quantitative use of recyclates in their products.

Implementation:

For the implementation of such a standardisation project, which is geared towards the definition of clear requirements on accepted pollutants and their respective tolerable maximum quantities in the recyclate, an overarching framing of the corresponding standardisation activities can certainly be helpful. This can be achieved, for example, by incorporating the conceptual approach outlined here and further elaborating it within the scope of the activities just launched

[162] e.g. due to further necessary functionalisation or due to contamination & "inherited burdens" from the first phase of use, which cannot be separated with a justifiable effort.

[163] At this point, it is not a (chemical) legal approval, but a "practical" limitation of the range of use of the corresponding materials resulting from the consistent application of standards.

[164] This conceptual proposal applies independently of the discussions and work currently underway in the context of the REACH revision to review and adapt the "use descriptor" system.

for the Circular Economy Standardisation Roadmap[165]. The same also applies to a corresponding mandating of the work.

Furthermore, given the substance information and expertise required for viable risk assessments, it seems appropriate that the primary responsibility for developing such secondary material standards lies with the (primary) material and article producers, as they:

- are responsible for the implementation of corresponding material-related recycling targets, respectively, product-related quotas for recycling and the use of recycled materials,
- can help address the challenges of circularity by designing materials and influencing the design of products,
- have the opportunity to influence the feasibility of recycling through the design/financing of collection structures for separate collection within the framework of extended producer or product responsibility schemes,
- must already provide and transmit the necessary substance information for controlling the recycling processes and for checking the "safe conditions of use" at this point in time.

The actors in waste management are to be involved in order to monitor the feasibility of the requirements critically.

5.2.1.8 Starting point 1.8: Restrictions on the re-use of problematic substances with narrowly defined exceptions

Content:

The use of substances with hazardous properties can be restricted by chemicals or product legislation in order to minimise possible harmful effects on human health or the environment. These restrictions can, for example, limit the use of substances in articles generally or specifically[166]. In addition, the use of hazardous substances is also restricted by the fact that they are only used in safe uses along the life cycle identified according to the REACH chemical safety assessment. If certain areas of use are not identified as "safe" in the registration and if such evidence is not kept by the user himself, a de facto binding restriction of substance use follows.

A new life cycle begins for a substance when it is recycled and placed back on the market. At the time of re-marketing, the same legal framework conditions apply in principle as for the primary materials. However, it is possible that the use of a substance has been restricted in a material or product since it was first placed on the market and that corresponding recycling would therefore no longer be possible. However, there are individual examples in narrowly defined cycles where such substances continue to be tolerated in order to extend the service life for the article as a whole or for certain components of products (materials) by means of further life cycles (resource conservation) and thus to take account of the idea of the circular economy. It may therefore make sense to grant narrowly defined exemptions also for the re-use of hazardous substances in order to realise positive resource effects. A prerequisite for the exemptions should be proof of the safe use of the recyclate in the intended use[167].

[165] Cf. https://www.din.de/de/forschung-und-innovation/themen/circular-economy/normungsroadmap-circular-economy/normungsroadmap-circular-economy-801630 - last checked 20.05.2022

[166] Restrictions are also imposed on mixtures, but are considered secondary in the context of recycling.

[167] Against this background, it is necessary to discuss how the design of the so-called "essential use" is developing at the EU level. The question here is whether it can be deduced from the goal of a circular economy following Green Deal that well defined closed-loop recycling solutions may be considered "essential". This could then mean that the prolonged use of products, e.g. through preparation

Function:

The adoption of general restrictions within the scope of REACH with clearly and narrowly defined exemptions creates an effective protective framework against

- unintended (broad) uses of hazardous substances and
- substance inputs via imported articles.

They also support legal certainty in the use of secondary materials defined according to the exemptions.

Implementation:

The elaboration and design of restriction proposals under REACH is carried out by the competent authorities of the Member States[168] or the EU Commission (if necessary, with the participation of technical authorities). The determination of the use patterns of the substances and the exposure conditions occurring with manufacture and use in particular represent a relevant effort here. In addition, as part of the necessary socio-economic analysis by the authorities, the known possible alternatives of the substance to be restricted must be evaluated and the costs of the planned restrictions must be quantified for a case-specific number of options to prevent inputs of a substance into the environment.

The active support of these processes by the market players can lead to significant relief and acceleration of the procedures.

Agreements between the environmental administration and the industry associations may be helpful here. Within the framework of the ecodesign discussion (starting point 1.2) and the standardisation work (starting point 1.7), the industry players will have to collect corresponding information that is to be passed on.

Excursus: Possibly new regulations for restrictions in the future

In the context of the REACH revision, a reform of the restriction process is also currently being discussed. Among other things, it is planned to restrict particularly hazardous substances (substances that fulfil the criteria of an SVHC and substances that can damage neurological, immunological or respiratory systems) in consumer products and products for professional users, including articles, without proof of a concrete risk, but only on the basis of a generic assumption of risk. This procedure is similar to the existing Article 68.2 REACH with a broader scope in terms of substance properties and products.

In the course of the possibility of enacting generic restrictions as well as in the context of all other chemicals regulations, the concept of "essential use" should also be applied in order to define exemptions from regulations. Both the planned implementation of the generic approach to risk management and the definition of "essential use" will change the framework conditions for recycling and preparing products for reuse.

for reuse or further use of individual (pollutant-containing) materials in well controlled cycle, can represent a criterion for qualifying such a use as essential.

[168] In Germany, the higher federal authorities responsible for the various objects of protection (UBA, BAuA and BfR) or the "Federal Chemicals Office", which coordinates national activities.

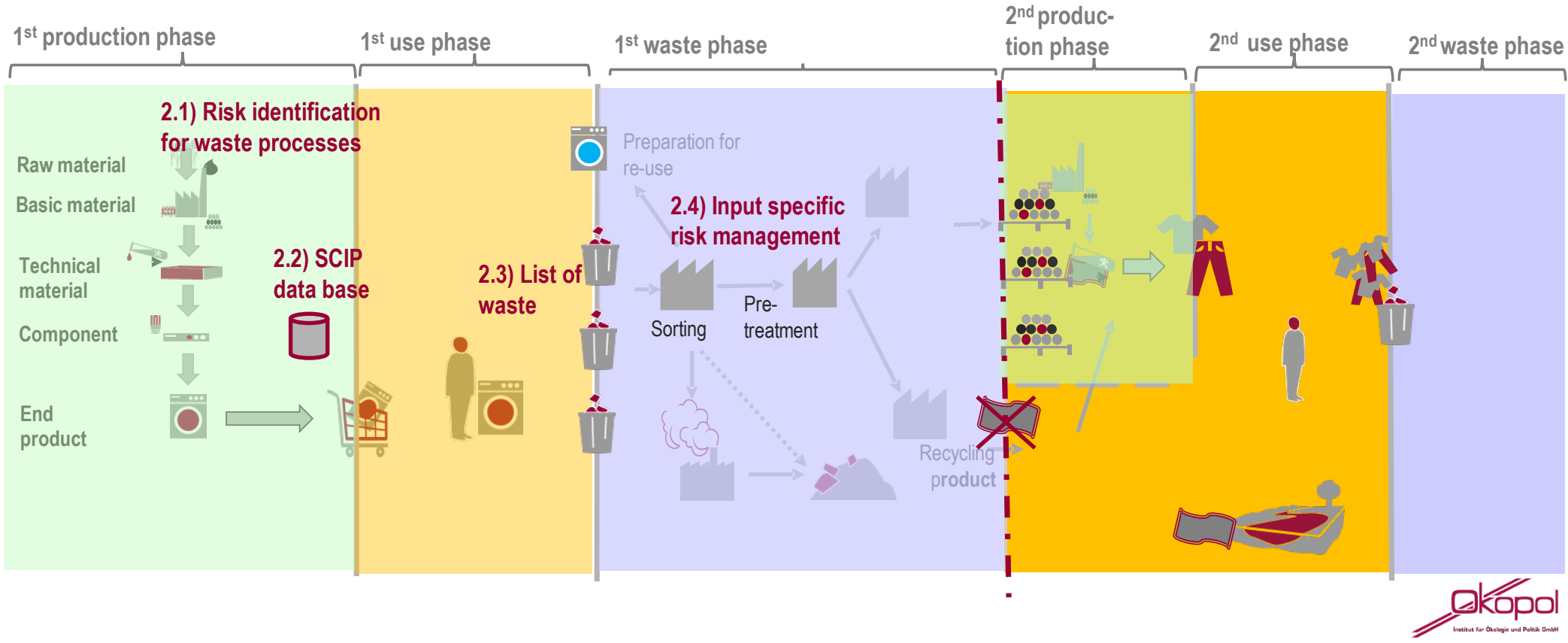
5.2.2 Optimised management of material risks within waste management

To address the tendency towards imbalance in the management of material risks of waste from articles within the waste management sector, the following four approaches are suggested:

1. Determination of " conditions of safe use" in typical waste treatment processes within the framework of substance registration
2. Implementation of waste stream related query options in the SCIP database
3. Adjustment of the mirror entries in the waste list
4. Implementation of input-specific risk management measures.

In the following, these starting points are assigned to the life cycle stages in the overview graphic before they are then briefly described.

Figure 46: Starting points for improving risk management within the waste phase



Source: own representation, Ökopol

5.2.2.1 Starting point 2.1: Determination of the " conditions of safe use" in typical waste processes in the context of substance registration

Content:

As part of the chemical safety assessments, registrants also identify and document the conditions of safe use. This also applies at least to the waste treatment processes that are common or can be expected (and thus must be considered from a risk perspective).

The "usual" release situations to be considered and thus also the basis for corresponding exposure scenarios are in particular:

- an exposure of humans or the environment to dusts from typically dusting processes, e.g. crushing, cutting and shredding,
- the release of substances from combustion processes if they are not destroyed there,
- the discharge of substances into surface waters following a release from the article matrix, e.g. as a result of outdoor storage of "article waste".

Function:

The identification of " conditions of safe use" for typical waste management processes enables operators of waste treatment facilities to match their workplace risk assessments and analyses of emissions from the processes to the environment with manufacturers' specifications on conditions of use and measures to reduce emissions and exposure.

While the results of the assessments regarding hazardous properties for the registered substances can be viewed on the ECHA website, the information on which "hazardous" constituents may be contained in a waste stream must be accessed via the corresponding query options of central databases on substances in articles (SCIP database) (=> starting point 1.2 & 2.2).

Implementation:

In general, there is already an obligation to also consider waste treatment in the context of the chemical safety assessment. However, due to inconsistencies in the REACH text, this requirement has so far neither been implemented by the market actors nor demanded by the authorities.

However, the legal basis could be clarified comparatively easily through corresponding clarifications that feed into the ongoing processes for the REACH revision.

Appropriate simplified modelling and determination options exist for the designated waste-typical process conditions, so that no excessive additional work arises for the registrants. The confidentiality interests of registrants would have to be taken into account in an appropriate form when publishing safe use conditions.

5.2.2.2 Starting point 2.2: Implementation of waste stream related query options in the SCIP database

Content:

In order to be able to use the information on hazardous substances in articles from the SCIP database (with the extensions already proposed above for field of action 1) for risk management in waste treatment processes, it is necessary to link the product or device-related information with waste streams.

For this purpose, the SCIP database would have to provide that one or more probable waste types are indicated for each product.

The waste operator could then obtain a listing of possible hazardous contents for "his" waste type/collection group via corresponding queries.

Function:

Access to substance-related information from the safety assessment of registrants (=> starting point 2.1) and on the composition of articles (starting points 1.2 & 2.2) enables operators of waste treatment processes to carry out very targeted and fact-based assessments of possible risks and to implement appropriate protective measures.

Implementation:

In the opinion of the study authors, implementation requires a revision of Article 9 (2) of the WFD and the corresponding subsequent national regulations in the Member States.

In the implementation, the ongoing discussions on the relationship of SCIP data with other product-related data files, if any, in relation to the implementation of a "Digital Product Passport" in the context of the SPI implementation must also be taken into account.

5.2.2.3 Starting point 2.3: Review/adjustment of mirror entries in the waste list

Content:

The waste list is systematically reviewed with regard to waste consisting of objects that were articles in the use phase ("product waste"). For waste types where hazardous substances are included in the material matrix of the end-of-life products, a deletion of the mirror entries is examined if it is ensured that appropriate forms of risk control are implemented in the material flow[169] and at the treatment facilities.

Function:

By deleting the mirror entries for wastes, the currently existing challenges in the proper classification of complex products as well as the existing grey areas in the absence of classifications as "hazardous" are avoided and the enforcement bodies are relieved.

If, in the case of waste from end-of-life products, hazardous substances are integrated into the material matrix of these end-of-life products, it seems appropriate to assume that no risks systematically differing from those of the preceding use phase arise from their proper collection, storage and transport.[170] Thus, according to the authors' assessment, the risk management instrument of the mirror entry can be dispensed with for these steps of waste disposal. For the further risk-related control of the subsequent treatment steps of complex end-of-life products, the purely binary waste classification (without/with mirror entry) is not differentiated enough ("anyway"), as stated elsewhere in the report.

Implementation:

According to the discussions held in the project scope, an adaptation process of the European waste list is required for implementation.

[169] These ensure, for example, that no waste is exported to countries where no orderly waste management structures exist.

[170] This explicitly does not apply to products in which the hazardous ingredients are contained in fillings with liquids or dusty materials, such as used cartridges from laser printers that contain residual toner.

5.2.2.4 Starting point 2.4: Implement input-specific risk management measures

Content:

The operators of waste treatment and recycling facilities use the information on specific risks caused by the hazardous components (cf. starting point 2.1 and 2.2) of the waste streams they handle for their risk analyses (hazard assessments, emission considerations) and review existing risk management measures.

Function:

Improved access to specific risk information (data from the chemical safety assessment) will significantly simplify the waste management actors' own "specific" risk analyses.

The transparency created by access to information also makes it easier for the occupational safety and health authorities and plant law enforcement to comprehend whether available risk information is being adequately taken into account.

Implementation:

The use of available information for their own risk analyses is a support for plant operators and a legal requirement in occupational safety and health. No additional implementation measures are needed here.

The designated enforcement activities are already fully implemented today. However, appropriate enforcement notices and/or training may still be needed to ensure that the competent bodies demand the use of the additional accessible information and thus ensure a uniformly high level of protection.