Landfills as a Pollution Sink in an Environmentally Sound Recycling Management

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The vision of a full recycling economy disregards the fact that landfills are indispensable as a pollution sink in an environmentally sound recycling management. Waste management will continue to require landfills in the future. In order to avoid erroneous developments, an integral concept for an all-encompassing waste management is needed.

1. Introduction

The European Commission presented the flagship initiative *A resource-efficient Europe* to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions on 26th January 2011 [1]. The target of this initiative is the drastic reduction of Europe's raw material consumption in order to make it less reliant on imports and strengthen its economy's competitiveness.

The long term planning envisages several coordinated roadmaps as its main components. The roadmap to a resource-efficient Europe, containing the relevant targets until the year 2050, was also presented to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions on 20th September 2011 [2]. Under the heading *Turning waste into a resource*, the vision of a full recycling economy is described, in which waste generation is reduced and waste is to be viewed as a resource. The milestone stipulates:

By 2020, waste is managed as a resource. ...More materials, including materials having a significant impact on the environment and critical raw materials, are recycled. ...Energy recovery is limited to non recyclable materials, landfilling is virtually eliminated and high quality recycling is ensured.

In this context, the Commission is going to review the existing prevention, reuse, recycling, recovery and landfill diversion targets in 2014, in order to move towards an economy based on reuse and recycling, with residual waste close to zero.

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The Committee of the Regions supported the flagship initiative *A resource-efficient Europe* through which efficient usage of resources is anchored into a number of political topic areas (i.a. waste management) in its statement [3]. Under the heading *Making the European Union a 'circular economy'* it

- calls for a zero-waste society to be the objective, through optimising waste prevention and seeing waste as a resource within a circular economy based on a materials cycle (Nr. 69);
- points out that local and regional authorities have significant scope to promote recycling beyond the current EU targets, with many pioneering cities and regions already going far beyond the minimum European recycling or landfill diversion targets and now aiming to achieve zero waste to landfill or incineration and high levels of recycling of household waste; in view of this, can only urge the European Union and the Member States to further encourage the introduction of instruments to promote recycling that are used by high-performing cities and regions, especially in regions that are less advanced in this area (Nr. 75);
- asks the European Commission to bring forward its assessment of the benefits of introducing binding EU waste prevention targets (Nr. 76).

Considering the high value of this waste policy demand by the European Commission, the question needs to be answered whether this target is still suitable with regard to the experiences already gained and the current requirements and also, whether it is compatible with the targets and requirements of precautionary environmental protection.

2. The illusion of a full recycling economy

As a central element for problem solving in the context of the handling of waste and in connection with the further development of waste management, a full recycling economy with closed material cycles, mirrored on nature's image, is propagated.

This vision is expressed in the description of the new waste law as *Recycling Act* (German: Kreislaufwirtschaftsgesetz (KrWG)) [4] through deletion of the word *waste management*. By transferring natural material cycles on to a recycling management, in other words the recycling of technical products, important differences are overlooked. One runs the risk of having higher expectations than can ever be fulfilled in reality. The vision then becomes an illusion.

The fundamental differences between the production of organic substances in nature and products developed by man are based on their material composition, which is immediately linked to their suitability for recycling. The central element of organic substances is carbon, which is built into different organic compounds (e.g. carbohydrates, fats, proteins). These compounds are accessible for degradation. In addition, *time* is no limiting factor for nature, in comparison to the activities by man.

For products which are developed for use by man, metals, mineral raw materials as well as synthetic compounds are used in great quantities and sometimes exclusively in addition to carbon (compounds). These are rarely or only to a very limited extent part of the natural material cycle and not accessible for degradation. They are usually stored outside natural material cycles in raw material reservoirs and are drawn from solely by man for the production of technical products.

The background for the complex composition of technical products are the diverse demands towards their functionality, which often oppose a suitability for recycling. For example, the demands towards the front of a building are very diverse: heat protection, moisture

protection, light transmission, sun protection, resistance against mechanical stresses, visual design and low weight. In order to fulfill all demands, whilst also paying attention to costs, different materials have to be combined in complex composite constructions that are not suitable for full recycling[1]. This is also exemplified during the insulation of a cellar wall against moisture or the heat insulation of brickwork with insulating material. The insulation coating and the brickwork can no longer be separated. The heat insulation of the building may possibly be separable from the brickwork, but a recirculation into a material cycle is not possible. The same applies to other complex products, e.g. cars and electrical equipment, which are faced with a number of functional and other demands.

This also explains, that it is possible to feed production waste, produced for example during the manufacturing of plastics, immediately to the production process. However it would not be possible to feed the individual constituents of complex products back towards the original production level. The recycling of cars and electrical equipment exemplifies this. An exception can be seen in the recycling of steel, even though here too certain alloy components can no longer be removed. Complex products on the whole can no longer be brought back to their chemical origins with justifiable efforts.

As regards the use of mineral wastes as a substitute for primary raw materials it is often overlooked that these are not purposely produced, but result from other uses of raw materials (e.g. generation of metals or energy) or during the new building, rebuilding or demolition of building sites (e.g. construction waste, road construction waste). It therefore has to be expected, that their composition is not exactly the same as that of the raw materials which they are replacing, but instead that they are influenced by the raw materials brought into the processes or the original use they were subjected to. Mineral waste can therefore be highly distinctive from primary raw materials as regards its pollution load (solids) and its release of pollutants (leachate), assuming they have comparable physical characteristics [5].

Experiences from the last few years have shown, that recycling measures can not only result in severe environmental pollution, but that the added securing and rehabilitation measures which come up later on can also bring damage to national economies. The basic principle of environmentally sound waste management should therefore not be *reclamation*[2] *at any cost*. The former senator for the environment in Hamburg, Vahrenholt, already pointed to the following in 1995 in connection with the recirculation of polluted waste into the material cycle [6]:

A recycling management, which continuously enriches these materials through their reclamation, cannot be our target. That would not be environmentally sound recycling management. In an environmentally sound recycling management, there has to be pollution sinks, as long as the products that surround us are loaded with pollutants.

Despite the well-meaning efforts, many (so called) *recycling processes* are open systems with a high risk of accumulation of noxious substances in water and soil with additional external immissions of pollutants. The indispensable requirement of pollutant reduction for

[1] § 3 Abs. 25 KrWG: **Recycling** is defined for purposes of this Act as any reclamation process through which waste is transformed into products, materials or substances for either the original purpose or other purposes; it includes the processing of organic materials, but does not include energy uses or processing into materials intended for use as fuel or for backfilling.

[2] § 3 Abs. 23 KrWG: **Reclamation** is defined for purposes of this Act as any process whose primary result is that the waste is reclaimed within the facility or in the rest of the economy, either by replacing other materials which would otherwise be used to fulfil a particular function, or by preparing the waste so that it can fulfil such function. Annex 2 contains a non-exhaustive list of reclamation processes.

the guarantee of functioning recycling is mirrored in the position of the council of experts for environmental topics towards the reclamation of waste, who formulated as follows in an environmental report in 2000 [7]:

Only a thorough check of all advantages and risks of the actual used reclamation methods and the relevant reusable materials, the residual products and the emissions will allow for a verdict over whether the chosen reclamation method is more environmentally sound in the long term than the controlled elimination. The council of experts is worried, that especially regarding the reusable materials held in the material cycle and the products resulting from them, not enough is known about the long term effects for environment and health and suggests, that …relevant precautions should be taken.

In his 2002 report he adds to this demand by pointing out, that blanket statements about the advantages of reclamation are not suitable and therefore should also not be permissible [8]:

Whether reclamation of waste is actually more environmentally sound than its elimination, can therefore not be said across the board but instead must be viewed case by case, for specific types of waste and reclamation methods, through comparison of the stated environmentally relevant advantages and disadvantages. Whether reclamation or elimination is the more favourable option from an environmental viewpoint, depends on the assessment of many points. The result may differ depending on the relevant circumstances. …

The problems found with assessing this matter, however are highly complex. To demand that it should be possible to steer each individual case of waste in its concrete composition towards its correct disposal method in the given circumstances would be destined for failure. …

Against this background Brunner [9] rightly points out that in relation to the target of *full reclamation* of waste, the target is in fact not *to move waste in a circle*. Not the recycling management is the target, but the protection of the environment and man. The recycling management is merely an instrument for reaching this target. Therefore the success of waste management should not be measured purely on the basis of recycling rates, but instead based on the facts of how the actual target was reached. The methods which help to lead the greatest amount of pollutants in the right direction, are hence to be preferred.

The vision of a full recycling economy should also not disregard the fact that next to the differences pertaining to the degradation and pollution of the recycling of organic substances produced by nature and those products developed by man, there are also differences regarding the physical suitability for the planned use. Products coming from natural processes are usually recyclable in an unlimited manner because they are degraded into chemical elementary parts and componuts and rebuilt into their original form. A separation of complex products built by man down to this level is usually not possible. Even the recycling of paper is limited due to the shortening of its fibres. The continued use of mineral building materials at the same valuable level is very limited too, due to the physical stresses it is subjected to during its use and the resulting lowered technical quality.

In conclusion many so called recycling processes are in fact cascaded uses due to the lessening technical characteristics of the used materials that require energy reclamation, thermal treatment or the deposition in a landfill site at the last level of the cascade. This fact corresponds with the observations made on natural recycling processes. Even the non-humanly influenced water cycle knows of sinks in which the sediment carried along in riverbeds or dissolved salts in oceans are left behind as *salt sinks*.

3. Development tendencies in waste management

Waste management has developed empirically in the last 40 years since the coming into force of the *Abfallbeseitigungsgesetz*. An integral and conclusive scientific and technological concept that links the different specialist aspects logically and without contradiction, cannot be seen. Waste management has been shaped mainly by political, emotional, legal and economical influences and only to a limited extent by specialist technological demands.

This also explains why, considering the debate about climate protection and the avoidance of CO_2-emissions, the composting of packaging materials made from biodegradable materials is propagated and privileged in legal rules. The biodegrading of this type of waste is only possible in composting plants, which have high energy consumption due to their technical infrastructure (for example electro motors for shredding, mixing, transporting, screening, separation, aeration, watering). The generation of this energy uses up fossil raw materials and causes CO_2-emissions.

Against this background it is not justifiable or understandable that these wastes of high calorific value, which are basically compounds made up from carbon, hydrogen and oxygen should not be energetically reclaimed or thermally treated using the energy contained within them and releasing CO_2 and water in the process, but instead are to be degraded into the same components (CO_2 and water) by microorganisms using energy in composting plants [10]. Thereby the disposal[3] method with the highest emotional acceptance is chosen, not the one with the lowest impact on the environment.

This is also surprising because the extensive, scientifically shown criticism against the composting of products made from biodegradable materials with a need for disposal (e.g. packaging materials) has been supported by several groups relevant to society for a long time [11].

Furthermore it is indisputable that a considerable mass of waste is produced through measures of environmental protection (*environmental protection waste*). This includes for example polluted soil material from the remediation of contaminated sites, filter dust from incineration plants, waste from the cleaning of industrial plants or asbestos waste from the remediation of buildings. A thermal treatment (vitrifikation) is usually not suitable due to ecological (use of fossil raw materials, CO_2-emissions) and economical reasons. Recycling is not possible due to the contained pollutants.

For the purpose of protecting the environment from these types of waste it is therefore compelling, to deposit them in overground and underground landfill sites [12]. Despite the clear circumstances on a national level (Federal Ministry for the Environment – BMU) the *Target 2020* is still being envisaged which stipulates that until the year 2020 all waste is to be reclaimed. While the BMU has meanwhile moved away from this target and still considers landfilling to be vital [13], the European level and environmental non gouvernmental organisations (ENGO) are still holding on to the zero-waste target for landfill sites.

This is a worrying prospect. Despite the proven requirement, during the approval and planning process sponsors of landfill site projects have to deal with the criticism coming from local and regional politics as well as citizens´ initiatives, in turn caused by the political signals sent down from higher levels (federal government, EU), saying that landfilling is apparently no longer required. If there is no countermovement to this development, there is a danger that

[3] § 3 Abs. 22 KrWG: **Waste disposal** is defined for purposes of this Act as reclamation and elimination procedures, including preparation for the reclamation or elimination.

- there will be disposal bottlenecks in some regions and some classes of landfill sites,
- the costs for disposal on landfill sites will rise due to the lower landfill volume and increased transportation distances,
- waste will be stored in questionable *recycling projects* in future.

It also has to be considered, that at the moment and in the future due to the politically decided exit from atomic energy and the linked deconstruction of nuclear power plants, waste is created which, because of the plans by the radiation protection laws, even upon its release can only be deposited on landfill sites (release based on § 29 Abs. 2 Nr. 2 Strahlenschutzverordnung). Opposition is on the rise against the storage of this type of waste on technically very suitable landfill sites.

Another aggravating factor is the fact that the success of waste management measures is increasingly being measured on the basis of reclamation quotas. These quotas find their legal basis in the waste framework directive and the Kreislaufwirtschaftsgesetz.

Complex factual situations and the environmental effects linked to the reclamation of waste cannot be described by way of a quota, in other words by the relationship between the reclaimed mass of waste and the total mass of waste. According to Articles 10 and 13 of the waste framework directive and § 7 Abs. 3 of the Kreislaufwirtschaftsgesetz, reclamation of waste is only permissible, if it is non-noxious.

However, legislation with material benchmarks for the assessment of non-noxiousness of the recycling of mineral waste, the by far largest stream of waste, does not exist on a European or a national level. In addition, there is no scientifically proven link between recycling quota and non-noxiousness. A recycling quota delivers no contribution to the precautionary protection of soil and water and is in so far merely counterproductive.

The politically desired favouring of reclamation goes hand in hand with a highly asymmetric regulation of the relationship between reclamation and elimination[4] of waste [14]. The elimination of waste in incineration plants is regulated by the 17. BImSchV and the deposition in landfill sites by the Landfill Ordinance (Deponieverordnung) respectively, supported by analogue legislation on a European level and containing technically sound and mature legal rules for the running of such sites whilst also considering the measures of precautionary environmental protection. On the other hand no such rules exist for the reclamation of large waste streams (e.g. mineral waste). This applies to both its use in technical construction measures as well as the backfilling of pits and quarry with soil material.

Due to the complex and comprehensive demands towards landfilling and the linked costs for operating a landfill site, the asymmetric regulation leads to evasion measures with disadvantages for the environment and the operators of plants which adhere to high environmental standards. As a result waste streams will be moved over towards the area of recycling of mineral waste, which is *regulated* only by vague legal terms. The cost effective and large scale distribution of waste is thereby favoured.

[4] § 3 Abs. 26 KrWG: **Elimination** is defined for purposes of this Act as any process which is not a reclamation, even if the process has reclamation of material or energy as a side-effect. Annex 1 contains a non-exhaustive list of elimination processes.

This highlights the problems linked to the current targets being set in waste management at present, where reclamation is pushed to the forefront as the sole problem solver and elimination (landfilling and thermal treatment) of waste is viewed negatively. It also shows that the requirement of pollutant removal und destruction (*kidney principle*) and the requirement of pollution sinks have not made their way into the current political discussions regarding waste management, even though the council of experts for environmental topics already expresset its concerns in 1996 [15] that with the coming into force of the Kreislaufwirtschafts- und Abfallgesetz and with the preference given to reclamation of waste as formulated therein, there would be increased pressure on the soil and large scale reclamation of waste, which must not gain the character of a large scale landfill. The supreme court (Bundesverfassungsgericht) already took a clear position towards this in 1998 [16]:

The term non-noxiousness of reclamation as used in § 5 Abs. 1 Nr. 3 BImSchG clarifies with regard to waste management duties, that what is demanded is not reclamation at any cost but rather environmentally sound reclamation.

4. Continued requirement for landfilling in the future

In conclusion it can be noted that in future there will be continued requirement of landfilling volume. This stands true especially as regards moderately contaminated mineral waste (class I landfill site). Against this background and with a view to the future developments of publicly available landfill sites, questions arise that the author answers on the basis of personal experiences:

- Are waste management industry and waste producers adequately prepared for the demand on landfill volume?

  The topic *construction and operation of landfill sites* does not currently seem to play an important role at waste management industry and waste producers. At present there is sufficient landfill volume available, so not all industry members seem to be aware of the impending changes and the resulting steps. There are however a few medium-sized companies that are dealing with the topic more in depth and want to construct and operate landfill sites [17].

- Are there short-, middle- or long-term concepts for the deposition of non-recyclable and non-treatable waste?

  Currently there are no signs of and consistent integrated concepts for the deposition of non-recyclable mineral waste being in existence or being developed. The industry in question is discussing the recycling of mineral waste at the moment. The administration (federal and local) and politics are also not making it their main focus.

- Is pressure rising regarding the backfilling of pits and quarry?

  The pressure on pits and quarry to take in mineral waste as *waste for recycling* will rise, especially due to the cost of landfilling (adherence to the requirements of the Deponieverordnung) and the long distances to cover during transportation.

- Will the costs for deposition of mineral waste rise (less landfill sites with less volume and longer transportation ways)?

  Due to the sinking number of cost-effective landfill sites of class I for the deposition of moderately contaminated mineral waste and the longer transportation distances it is to be expected, that the cost for deposition of mineral waste will rise. This will in turn increase the pressure on recycling and especially on the determination of allocation values for the recycling of mineral waste.

In order to counteract a worst case scenario, as it may result from the answers to the aforementioned questions, suitable concepts with consideration for the following points have to developed and implemented in due course:

- Development of a comprehensive disposal concept for all types of waste, with regard being given to the deposition in landfill sites. The zero-waste target has to be moved away from and a concept has to be worked out whereby the real requirements and framework conditions are taken account of.
- Development and implementation of a concept for the construction and operation of landfill sites by the waste producing and waste disposal industry. These should firstly be developed at regional level by the affected circles (industry and public waste disposal authorities) with support from higher authorities.
- Consideration of the follow-up costs from the recycling of mineral waste in technical construction measures (embankments, road construction, parking lots, industrial and commercial areas). The costs accruing to the user of waste, must not be pushed onto him but instead be internalised and be borne by the waste producer. For technical construction measures in which mineral waste is to be used, cost models have to be developed that not only take account of the cost of construction materials but also of the follow-up costs (e.g. maintenance, disposal costs at the end of use).
- Consideration for the later use of landfill sites already in planning. Landfill sites can be brought to a useful purpose once the deposition phase is finished.
- The lack of landfill volume must not become a burden for the protection of soil and water. Soil and water protection laws must be consistently adhered to during the backfilling of pits and quarry and the recycling of waste in technical construction measures.

The revised LAGA-Guideline 20 [18] with the new technical rule for the recycling of excavated soil/ soil material (TR Boden) as the basis for evaluating the non-noxiousness of recycling does not correspond with the current scientific knowledge as regards the allocation values for evaluating leachates. However, it does correspond with the current legal position, including the *Tongruben* judgement and can therefore be used in the interim until federal law is implemented as necessary. The technical and material requirements of this guideline reliably prevent – if used and functioning as the binding part of an authorisation for back-filling – that clay, sand and gravel pits are filled with unsuitable waste. This means, that the backfilling of pits and quarry with unsuitable waste can already be prevented with the current legal rules and guidelines [19].

5. Outlook and conclusion

The development of waste management is linked to the tendency of avoiding the scientific debate about content, technical requirements and interests by using legal definitions. This can also be seen in the formerly wide definition of *waste* which is now increasingly becoming *defined away*. Next to waste there are by-products and animal by-products. During the discussion of waste management topics terms such as material, product, recyclable material, raw material or residual material instead of waste are increasingly used and the term waste management is replaced through terms like resource management, material stream management or recyclable material management.

In the context of the target of strengthening the prevention[5], reuse[6] and recycling of waste as stipulated by the Kreislaufwirtschaftsgesetz, the council of experts for environmental topics states that the term *waste* in its original sense should no longer exist in the future [20]. Nevertheless, from a scientific viewpoint it is undisputed that the avoidance of the term *waste* does not avoid the issues caused by the treatment of waste.

The legal determination of a waste hierarchy in the waste framework directive and the Kreislaufwirtschaftsgesetz is welcomed in the discussion about the further development of waste management by those politically in charge. However it cannot be substantiated with scientific or technical reasoning. This is shown by the example of feedstock recycling of the plastic fraction from the treatment of shredder residues from the recycling of cars as a reducing agent in blast furnaces. From a scientific viewpoint it is undisputed that purified plastic waste that is blasted into a furnace in the form of plastic granules, materially substitutes primary carbon carriers (coke, heavy fuel oil) and that this way of reclamation is ecologically more favourable than the recycling of plastic waste [21]. Nevertheless it is put behind the recycling in the waste framework directive and is therefore discriminated against.

The scientific contradictions within the waste hierarchy and the continuously increasing amount of contentious questions surrounding the distinction *reclamation/elimination* and *waste/by-product* as well as *end of waste status* will also lead to further pressure on all enacting authorities, who will not be able to deal with the pressure due to their limited resources as regards personnel numbers and qualifications. In principle there is of course room for individual deviations from the rule. However, the efforts linked to this (e.g. creation and evaluation of reports) are immense for the involved waste producers, disposers and authorities and can lead to arguments which will increasingly also involve the courts.

A fast federally coherent and non-contradictory implementation, which is vital especially in view of securing the same conditions for competition and security of investments of the involved industry, is being put into danger by this divergent development (complex rules vs. personnel numbers and qualifications).

As a result, we can establish that with a view towards the activities of the European Commission and the target of the Kreislaufwirtschaftsgesetz, the prevention of waste and the reclamation of secondary raw materials from waste can contribute towards the reduction of usage of raw materials. Aside from the fact that the recycling of waste can only cover the raw material needs to a limited extent, the demand for a full recycling economy and its development into a zero-waste society with the zero-waste target for landfill sites and waste incineration plants, leads to predictable faulty developments.

It is necessary to have an integrated and consistent science and technology based concept of an all-encompassing waste management that links the different scientific aspects in a logical and non-contradictory manner. Based on this, requirements for the disposal of waste (= reclamation and elimination) must be determined in such a way as to secure protection of the environment.

[5] 3 § Abs. 20 KrWG: **Prevention** is defined for purposes of this Act as any measure taken before a substance, material or product has become waste and which is intended to reduce the volume of waste, the harmful effects of the waste on humans and the environment, or the proportion of pollutants in materials and products. This specifically includes internal recycling of materials, low-waste product design, reuse of products, extension of their operational life, and consumer behaviours targeted towards buying low-waste, low-pollutant products and reusable packaging.

[6] 3 § Abs. 21 KrWG: **Reuse** is defined for purposes of this Act as any process in which products or components, other than waste, are reused for the same purpose for which they were originally intended.

Within this concept, landfill sites as a pollution sink for contaminated wastes especially as they are created as part of environmental protection measures, remain vital. They are a fundamental element of a functioning recycling management. Only through removing and safely depositing contaminated waste in landfill sites it can be ensured that pollutant accumulation, large scale distribution of pollutants and a crash of the recycling can be prevented.

Incineration plants too are fundamental to an environmentally sound waste management. They use the energy from waste with high calorific value components which cannot be recycled with ecologically and economically justifiable efforts. At the same time organic pollutants are destroyed and biodegradable waste is being inerted in a controlled and environmentally sound manner. Incineration plants are indispensable in the destruction of pollutants and take over a compellingly necessary *kidney function* for waste with a high calorific value.

The demand for a zero-waste society and the zero-waste target for landfill sites and incineration plants is therefore an illusion which has to be strongly opposed, especially with a view towards the successes that have so far been generated by a well ordered waste management.

6. Literature

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