Future waste – waste future

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'Future waste' is a term not yet established in the waste community; actually it is a paradoxon. 'Future waste' is not dealing with current solid waste, but products that will become waste in the future. Due to advances in science and technology and priorities in politics, large quantities of these, often technologically complex, products have already entered the anthropogenic stock within a short period of time or are about to do so in the near future. As the majority of these items have relatively long life spans they will not immediately play an important role in waste management, however, once the product life time is over meaningful quantities of this 'future waste' will be generated. At that time we need to have appropriate waste management solutions available as these wastes: (1) contain valuable resources (e.g. precious metals and critical raw materials, usually in very low concentrations) and (2) pose specific new challenges to prevent hazards associated with their treatment (e.g. nano-materials).

What specifically does this term 'future waste' apply to? Some simple examples: lithium-ion batteries from hybrid and e-cars, wind turbines, photovoltaic cells and other components in renewable energy systems. These and similar products have a very long useful life and a substantial amount of this material has already entered the anthropogenic stocks – in Europe mainly during the last one to two decades. In the same way, China and other parts of the world are likely to follow. Based on political priorities and targets for renewable energy facilities, one can assume that this trend will continue indefinitely. New composite materials, such as glass and carbon fibre components, used in vehicles or in the construction of buildings are also proliferating. As a result of the respective product life-times these materials will probably remain in the anthropogenic stocks for the coming decades and will then become 'future waste'.

Apart from the long lived 'future waste' products, there are also examples with a short life cycle such as biodegradable plastics, the use of which is rapidly expanding in some countries, although consumption is relatively low today.

A common feature of 'future waste' streams is that the waste sector will be dealing with relatively low quantities of these wastes in the near term. In the beginning it is mainly production waste and broken components which result from accidents and technical breakdowns that enter the waste sector. Currently there are no high-quality recycling or treatment solutions in place for this 'future waste'; at best scientists and engineers are researching and developing innovative solutions for future applications. Some research projects in Germany and Austria, such as LIBRI, LITHOREC or LIBRES, developed the basic principles of lithium-ion battery recycling and provide fundamentals to recycling plant development. Other recovery options for 'future waste' are, for example, investigated in the CD laboratory on anthropogenic resources at the Technical University of Vienna. As another example researchers in Germany work on disposal solutions with regard to components of wind turbines.

At present, in most cases the currently existing waste disposal options are used to deal with the small quantities of 'future wastes'. Waste management companies are not yet interested in this 'future waste' because profits from treatment fees and revenues from processed recyclables will stay on a low level for many years because of the low volumes to be handled and the lack of markets for the processed recyclables from these emerging types of solid waste.

How do we overcome this hurdle as feedback from the waste/recycling sector is needed in order to improve the product design and, in turn, to increase recycling rates? Eco-design, currently not more than a buzzword, must attain higher relevance and must be closely linked to the recycling process. The whole supply chain must be evaluated by life-cycle assessment in addition to an economic assessment to define the benefits of developing suitable end-of-life recycling measures as part of the eco-design process for new products.

How should we prepare for management of these 'future wastes'? In fact, due to the absence of current economic stimuli, the development of recycling processes and new technologies for these 'future waste' streams probably needs to be initiated by regulatory measures such as producer responsibility and obligatory recycling rates. Legal requirements also promote re-use solutions, but re-use will only be a niche and special solution for minor quantities. Based on the European Union waste framework directive, EU member states are obliged to implement the waste hierarchy and producer responsibility regulations into national laws, which leads to pressure on waste management stakeholders to invest in the development and construction of waste treatment plants. In that context it is important that front-runners (early adaptors) can rely on stable political priorities in order to minimize the potential for stranded investments in recycling and treatment plants.

The concept of 'future waste management' suggested here thus comprises the following steps to be implemented in parallel:

- Apply or adapt existing recycling/treatment solutions.
- Develop and implement recycling/treatment technologies driven by target recycling rates set by regulations.

- Construct re-use solutions, even if only minor amounts of 'future wastes' may be avoided that way.
- Install feedback loops from the recycling sector to the production sector in order to stimulate expanded application of eco-design methodologies.
- Foster holistic assessment of production/recycling systems connected to certain products/services in order to demonstrate the benefits of implementing the concept of eco-design.
- Implement drivers (such as legal requirements, economic incentives or expanded research) to encourage a broader implementation of management alternatives for 'future wastes'.

The aim of this approach is to foster the utilization of 'future waste' through recycling and re-use, the support of life-cycle product design and the overall assessment of the production and recycling processes. Implementing this 'future waste concept' sooner than later will enable waste practitioners, manufacturers, and society (through their government leaders) to bridge the gap between the production and the recycling sectors before the volumes of this waste grow. Intensive communication between these sectors is paramount in order to allow for an effective implementation of the eco-design concept on the one hand and to close loops by recycling of waste streams on the other.

Due to the dynamic nature of technological advances and resulting changes in products, as well as the dynamic development of economic aspects of the waste sector (e.g. evolving markets for recyclables) the "future waste concept" needs constant monitoring in order to allow for adjustments and an effective setting of recycling targets and drivers.

The waste industry will face many new challenges in the years ahead regarding the management of solid waste comprised of current products at the end of their useful life, posing risks on the one side (e.g. nano-materials) and potentials for recoverable resources on the other (e.g. rare earth, precious metals). It is therefore important for us to work on appropriate waste management solutions now – including product design, waste logistics and waste utilization/treatment. *Waste Management & Research* is a forum to facilitate the exchange of knowledge about the handling of 'future waste' among the academics and professionals in the waste sector throughout the world; accordingly, any paper submission dealing with 'future waste' is welcome.

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