*Editorial*

WM&R

*Waste Management & Research*
1–2

DOI: 10.1177/0734242X211016975
journals.sagepub.com/home/wmr
SAGE

# How to improve an advanced waste management system

Imagine that you are tasked with improving the waste management system in a country or region that already accomplishes advanced standards in terms of recycling and recovery, as well as of landfill minimisation. What are the opportunities for improvement? Is it a matter of continuous progressive optimisation, or there is room for game-changing solutions?

Well, let us take a step back and introduce the framework of this challenge. Like for many other sectors, the management of waste varies widely in different parts of the world, moving from situations where the improper management is cause of illnesses, premature deaths and major environmental degradation to situations where companies are embracing advanced circular economy strategies and earning profits from the recovery of waste. In the former, stopping the leakage of waste in the environment by securing open dumpsites is the top priority; this would limit the pollution of underground and surface water by uncontrolled leaching, the severe air pollution due to uncontrolled burning, the littering into water bodies, etc. In the latter, the industrial strategies based on waste recovery might benefit from further interaction with the producer of materials that will become waste, but on the other hand, they must be able to cope with strategies of waste prevention, thus to discourage continuous and growing waste generation. Such approaches have already become critical in some countries that heavily rely on waste incineration but might in turn involve other increasing waste streams, such as food waste.

When talking about optimisation versus game-changing solutions, an interesting parallel with the automotive sector can be drawn. The internal combustion engine, invented in the mid-19th century, has been continuously improved in terms of combustion optimisation as well as exhaust gas cleaning technologies. This was due to the search of a greater fuel efficiency and to the necessity to comply with progressively stringent emission standards. In the European Union, the Euro 7 standard, expected to enter into force in 2025, is forecast to affect the true business of the traditional automotive sector, since the technical complexity required to achieve the new targets might make it too expensive, if not even technologically impossible to achieve. The sector then needs a game-changing solution, which for the time being has been apparently found in the electrification of the power train. The game is changed not simply because it allows for removing the harmful exhaust emissions causing air quality problems, but because of a step further in the energy conversion efficiency (an electric motor is three to four times more efficient than an internal combustion engine). Furthermore, a switch to electric vehicles might help to integrate and support the diffusion of renewable energies in the grid. On the other hand, electrification introduces new challenges in the waste sector, which must devise recycling and disposal measures to safely and efficiently handle end-of-life batteries and so on, but this is another story.

Therefore, which types of optimisation can be pursued in the current advanced waste management approach? Since collection is getting more and more crucial in delivering optimal performances by the whole value chain of recovery, as well as the most costly step in waste management, this is the first sector that could benefit from optimisation. It can be achieved by means of a complete switch towards door-to-door schemes that have proven to deliver a number of advantages in terms of quality check, of lower occupation of the public space, of citizens' engagement, to say the most important. Moreover, the choice between monomaterial and multimaterial collection deserves attention because for the latter the right coupling of waste streams will deliver better performances. For example, collecting plastics together with other materials, such as metals, might negatively affect the quality of both streams, as well as the actual recycling efficiency achievable. It has to be realised that what we simply call plastic is a true multimaterial stream because of the wide variety of different polymers (we can count up to 10 different output streams delivered to buyers of recycled material from a plastic sorting plant), making no sense to group plastics with other streams of recyclables. The continuous growth of plastic film in the waste stream, just to cite one specific issue, is posing a serious challenge to sorting plants because this material is prone to wrap around rigid items or even metals, impeding if not outright preventing their separation. This practice results for example in the loss of otherwise valuable aluminium cans that are entangled with plastics such that the cans are delivered to energy recovery or, even worse, to landfill instead of recycled. Aluminium and iron items should then be more effectively grouped with glass, whose sorting is getting more efficient thanks to the use of optical sorters, and where flexible plastics are not contaminating the output stream from sorting facilities.

Another option for optimising waste collection can be characterised by 'the right container for each stream'. While some waste streams can be collected loose, like paper or glass, many others require a disposable bag for their containment. The proper choice of such a bag must take into account its interaction with the sorting and recycling processes in order to avoid possible additional problems. In the case of food waste, paper bags are proving to be more compatible to the biological treatment process than bioplastic ones, especially when an anaerobic process is involved. Or again, when waste paper needs to be collected inside

a bag, the bag should be made of paper and not of plastics, like sometimes it is still the case.

A last step of collection optimisation entails the use of electric vehicles that emit substantially reduced levels of atmospheric pollution and are much quieter than collection trucks powered by traditional internal combustion engines. Reduced noise, for example, could enable collection scheduling during night-time hours, reducing traffic for commuters during the daytime. Moreover, such vehicles might be recharged with electric energy generated from waste-to-energy facilities, then opening a new avenue for the use of such energy, which in recent times has been neglected in favour of the more efficient thermal energy.

When it comes to sorting and recycling, we have seen a lot of optimisations, but no real game-changing solutions. The latter would be especially required for plastics, being the most challenging waste stream to deal with. The prospect for chemical recycling of plastic wastes is being considered an option to drastically increase its recycling performance that has long been stagnant in many countries, and well behind the most ambitious targets set, for example, by the European Union in its Circular Economy Package. Ignoring for now the discussion whether chemical recycling is a true material recycling or rather an indirect form of energy recovery, the sector is still at an early stage, with huge promises but no real full-scale industrial developments. Moreover, bioplastics are seen by some in the field, driven by the marketing and sometimes perceived by the citizens, as a potential game changer. But reality shows that without a more intense involvement of the waste industry, the flood of bioplastic items in the different waste streams expected during the foreseeable future is more likely to cause additional problems than to solve existing ones.

The real game-changing solution for waste management is probably linked to the ‘elephant in the room’ of this discussion, which is the eco-design and manufacturing of consumer products, aimed at avoiding waste in the first place, then facilitating material reuse and recycling at end of products’ lives. The current advanced waste management systems are probably close to achieving optimal results based on the current way of producing goods. If we want to make a real step further, it is the latter that we have to primarily work on, not the former. Goods that ultimately will become waste must be rethought starting from the early design stage, accounting for their prevention, for the possibility to reuse, or at least to easily dismantle or efficiently demanufacture them, and finally to recycle materials that are no longer able to be incorporated into the supply chain. At the same time, the role and behaviour of citizens can also become a game changer solution in waste management effectiveness. The previously envisaged new eco-design approaches must be fuelled by a strong citizen demand for more sustainable products. The market will follow very soon. But a robust sustainability assessment must guide such a transition in order to avoid a situation where, once again, the waste sector is forced to lag behind some decisions only taken upstream in the value chain of products, with little or no involvement by those responsible for waste management.

**Mario Grosso**
AWARE (Assessment on WAste and REsources) Research Group
Politecnico di Milano,
Milan, Italy
Email: mario.grosso@polimi.it