Building a bridge strategy for residual waste

Material Recovery and Biological Treatment to manage residual waste towards a circular economy

Condensed Briefing

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Introduction: Waste Management in the Circular Economy Age

The European Union, through its *Circular Economy Package*, has adopted an advanced roadmap on waste management for its Member States. Whilst pointing towards the reduction of waste and maximisation of reuse and recycling, this roadmap also requires giving a proper consideration for the management of residual waste.

The circular economy vision is all about preserving materials and resources in the system, and minimising so-called "leakages", such as landfilling and Waste-to-Energy (WtE). **Energy recovery from waste (through incineration or co-incineration) destroys vast amounts of resources, requires the extraction of new primary raw materials, perpetuates a linear economic model, and releases greenhouse gases (GHG) from fossil-based materials (e.g., mostly of plastics and artificial textiles).** Waste management such as this does not promote the achievement of a Circular Economy (which is why the EU lately adopted the DNSH principle, i.e. "Do not significantly harm " circular economy, which excludes incineration from the EU Taxonomy of Sustainable Finance and from the Recovery Funds) .

It is therefore of utmost importance to define a solid "transitional strategy" for the management of residual waste. A strategy which goes hand in hand with the transition from the current situation towards the full potential of the circular economy, so that compliance with the regulatory obligations for disposal is ensured and, at the same time, lock-in is avoided by being flexible. This "bridge strategy" should also support the national strategies, local schemes and the EU waste management system as a whole, while working collaboratively towards waste reduction, increasing reuse, recycling, and minimising disposal.

This briefing puts forward **Material Recovery and Biological Treatment (MRBT)** as a waste management approach that tackles the issue of transitioning. This approach, a combination of residual waste sorting (with a view to extracting materials for recycling) and biological treatment aimed at stabilising waste (so as to avoid methane emissions from landfills), provides the perfect opportunity for states to implement a modular waste management system that considers circularity and efficiency.

Residual waste: just a load of valueless stuff?

One must note that the separate collection rates which are being promoted in the EU's *Circular Economy Package*, cause a consistent reduction of residual waste, and imply a significant concentration of materials which are not yet captured through separate collection. **These include materials not currently targeted by separate collection, such as non-packaging plastics which are not covered by EPR schemes, but also materials which should be collected separately, but may erroneously be delivered with residual waste.**

The composition of residual waste is a valuable source of information that aids with:

- Comparing and combining percentages in residual waste with tonnages of separately collected materials, which helps us to calculate the capture rates of recyclable and compostable materials
- Informing decision making on priority actions and strategies to be considered, in order to:
    - Improve the capture of materials that may be recycled/composted,
    - Redesign materials that cannot be recycled or composted, so as to make them reusable, recyclable or compostable, if not then to fully design them out of the production cycle,
- Visualising which types of materials may be worth targeting for further recovery before final disposal.

An analysis of the composition of residual waste should be carried out for all the aforementioned reasons, and also to design a comprehensive transitional strategy of waste management. Such an analysis is of particular interest in areas where separate collection has been implemented and optimised, as it shows the effect of this collection on the composition of leftover/residual waste. Tables 1a and 1b report respectively on the average composition of residual waste in 2019 in Milan, and in 2016/2017 in Ljubljana. In both cities, kerbside collection includes food waste for households and large producers, and separate collection rates of 65-70% have been met overall. The tables show two important factors to be considered when implementing the transitional strategy of Material Recovery and Biological Treatment (MRBT): an intriguing percentage of fibres and plastics, and a low percentage of biowaste.

MATERIAL	MILAN (Average 2019)
WEEE, HHW	0.1%
Paper and cardboard	29.3%
Other paper	3%
Plastic tableware	1.1%
Plastic packaging	13.1%
Other plastic	2.2%
Textiles, leather & rubber	6.6%
Iron	3.6%
Aluminum	0.8%
Multi-layer	1.1%
Bio waste	11.1%
Glass	5.8%
Nappies	6%
Fines <20	13.1%
Garden waste	3.1%
Total	100%

MATERIAL	LJUBLJANA (average 2017)
WEEE, HHW	0.87
Paper and cardboard	21.5%
Other paper	3.88%
Plastic (LD-PE, PP.PET,HD-PE)	10.08%
Other plastic	11.79%
Textiles, leather & rubber	7.67%
Iron	2.53%
Other metals	2,31%
Biowaste	10.91%
Glass	2.29%
Nappies	10.34%
Fines <20	10.91%
Treated wood	1.83%
Other waste (bones, ceramics, stones...)	2.11%
Tetrapak	0.99%
Total	100%

The regulatory context: an assessment of requirements of the Landfill Directive

The Landfill Directive (Council Directive 1999/31/EC) is a European Union directive that was adopted with the aim of reducing the environmental impact of waste disposal and promoting more sustainable waste management practices within the EU member states. The directive sets out specific requirements and standards for the operation and design of landfills to prevent or reduce negative impacts on the environment, such as soil and water pollution, greenhouse gas emissions, and other forms of environmental degradation.

The directive includes two key requirements: minimisation of biodegradable waste to landfills with specific phased targets, and an obligation for pre-treatment of Municipal Solid Waste (MSW) prior to landfilling. Thanks to the obligation to pretreat waste before landfilling, the Directive works towards the following strategic goals: minimisation of environmental impacts from landfill sites, and an increase of the cost of landfilling.

While previous infringement procedures have rightly ruled that waste landfilled without pre-treatment does not comply with the obligation stipulated by the EU Landfill Directive**, some industries have misleadingly argued that "this implies the need to build incinerators".** The EU Landfill Directive defines as "treatment", in Article 2, the following:

> h) "Treatment" means the physical, thermal, chemical or biological processes, including sorting, that change the characteristics of the waste, in order to reduce its volume or hazardous nature, facilitate its handling or enhance recovery.

Hence, as much as "thermal treatment" (i.e., incineration or co-incineration) is included amongst eligible types of treatment, it is not the only one, nor is it compulsory to consider it. Other types of treatment are equally suitable, provided they ensure the goal to "reduce the volume or hazardous nature of waste, facilitate handling or enhance recovery".

> Certain EU member states have, in response to the EU Landfill Directive, enacted regulations specifying maximum calorific values for landfill waste. Many decision-makers mistakenly believe these thresholds are also regulated by the Landfill Directive. These rules, predating comprehensive climate policies, prompt premature investments in incineration, undermining circular economy objectives as the regulations deter the separate collection of organics and food waste (since collecting organics typically brings along a remarkable increase of calorific values of residual waste).

How to define pre-treatment properly

The goal of the EU Landfill Directive can be summarised as the minimisation of landfilling (quantity and capacity of landfill sites) and its related environmental impacts**. The minimisation of the number and capacity of landfills in Europe should primarily be ensured through the reduction of waste and increasing diversion towards reuse, recycling and composting while, the minimisation of negative impacts should primarily consider the reduction of biodegradability.** With that in mind, the definition of "acceptable pre-treatment" should primarily consider a significant reduction in fermentability.

The correct way to implement effective strategies devised by the EU Landfill Directive must be to test the fermentability of the waste mass after pre-treatment. This would help in several ways. Firstly, it helps achieve - and is consistent - with the overarching goals of the EU Landfill Directive. Secondly, it meets the key requirement to minimise fermentability of materials in landfills. Thirdly, it minimises the release of greenhouse gases, while also leaving room for flexible operational solutions that do not cause lock-in or prevent high performing recycling and composting systems, as it would be, instead, after investing in incineration.

The concept of Material Recovery and Biological Treatment (MRBT)

With the regulatory context and the need for a bridge strategy in mind, this report turns to the concept of Material Recovery and Biological Treatment (MRBT). This is a waste management process that combines two key methods: material recovery, which focuses on extracting recyclable materials from waste, and biological treatment, which involves the decomposition of organic waste through biological processes.

The "bridge" strategy for residual waste management aims to achieve multiple goals simultaneously. It must comply with pre-treatment requirements to reduce negative impacts, decrease the volume of materials sent to landfills, and - above all - maintain operational flexibility within the waste management system so as to keep moving up the bar of ambition in resource management. To accomplish this, it's crucial to process residual waste in a way that allows for future adaptability and efficient material recovery.

This can be achieved by replacing the Refuse-Derived Fuel (RDF) production units in Mechanical Biological Treatment (MBT) plants with equipment designed to sort residual waste and recover valuable materials, ensuring a reduction in negative impacts at landfills, diverting materials from landfills, and maintaining operational flexibility for evolving recycling efforts.

MRBT is considered a sustainable waste management approach as it promotes resource recovery, reduces landfilling, and minimises environmental pollution. It aligns with the principles of the circular economy by maximizing the value derived from waste materials and contributing to a more sustainable and environmentally friendly waste management system. It distinguishes the differences from old-fashioned MBT to emphasise the intended goal of merging the recovery of some waste materials (instead of making them into a fuel) and the biological stabilisation of fermentable materials before landfilling

When discussing and examining MRBT, one key operational principle must be considered throughout:

Biological stabilisation of organics included in residual waste is only aimed at reducing fermentability and related impacts when landfilled. It is not an option for producing compost, nor should it ever be considered for that.

The foregoing takes into account the contamination of organics with other materials from the mechanical separation of waste. There is overwhelming evidence that showcases the efficiencies of separate collection as a precondition, in order to ensure the quality of composted materials, thereby maximising the benefits of this procedure and avoiding any potential negative impact.

Therefore, **this report considers MBRT as the appropriate bridge waste-management strategy.**

Possible structure and operational goals of MRBT

The proposed Material Recovery and Biological Treatment (MRBT) strategy comprises three main sections:

- **Separation of Dry Materials and Organics:** This involves using primary screens after bag openers to divide dry materials like paper, plastics, metals, and cartons from organics. Organics end up in smaller materials while dry materials are coarse.
- **Mechanical Sorting:** Coarse, dry materials are sorted further using equipment like ballistic separators, optical sorters, magnets, and eddy current separators. These processes can be customised to recover specific materials based on market value or cost considerations.
- **Biological Treatment of Organics:** Mechanically separated organics undergo a composting-like process to reduce fermentability. This involves forced aeration, occasional turning, and odour treatment with biofiltration and wet scrubbing. Anaerobic digestion can also be included, followed by aerobic stabilisation of digestate, enhancing energy balance and retaining part of biogenic carbon to make it into a renewable fuel (thereby displacing fossil sources).

Benefits of this MRBT approach include enhanced biochemical stability of fermentable materials in landfills, reduced weight of landfilled waste due to process losses and material recovery, and increased system flexibility. As a matter of fact, this strategy, designing sites with both composting technologies and sorting equipment, besides treatment of residual waste, allows for the separate processing of clean organics for compost production and mechanical sorting of separately collected materials (e.g. different plastic polymers, different fibre grades), which ensures adaptability and efficiency in waste management operations.

In a zero-waste oriented approach, it would be of fundamental importance to also include a **dedicated area where a permanent "Zero Waste Research Centre on hard-to-recycle goods and materials" should be hosted.** This would focus on items in residual waste which may be addressed through redesigning or new business models so as to make them reusable/recyclable.

The most important factor to consider throughout is the possibility to keep the system flexible, ensuring the ability to adapt to dwindling tonnages of residual waste as progress is made towards a circular economy. The reduction of tonnages of residual waste may be compensated by the increasing amounts of separately collected materials, still keeping an operationally and financially viable situation, and avoiding any tension at the interface between separate collection, circular economy and the need to use the installed capacities (as it would be with incineration), designed at a time when residual waste was significantly more relevant.

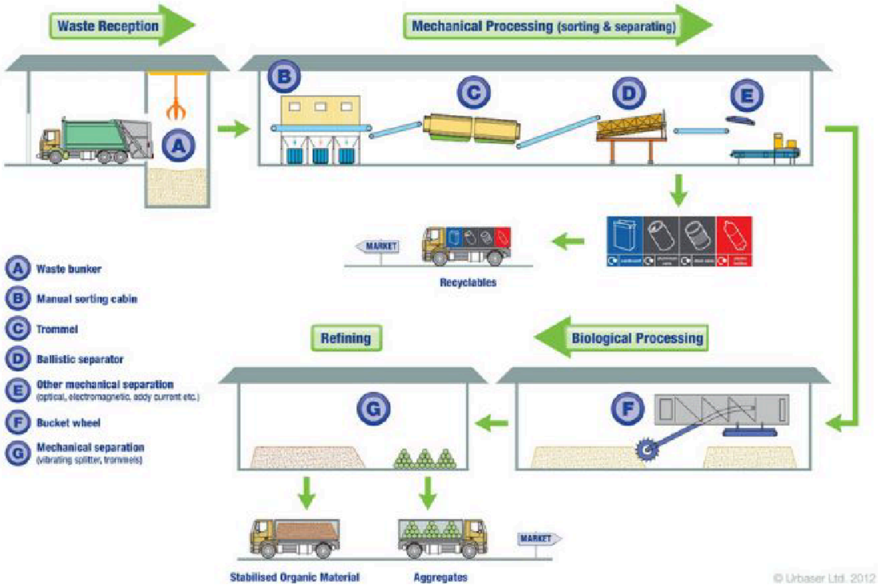

Figure 1: a schematic lay-out (slightly modified) of an MRBT site (source: Morris et al: What is the best disposal option for the "Leftovers" on the way to Zero Waste? Eco-Cycle, www.ecocycle.org/specialreports/leftovers). The lay-out is schematic and only intended to visualise main operational sections (separation, material recovery, biological stabilisation). As explained in the text, the combination and sequence may vary depending on local needs and conditions.

Why a bridge strategy for residual waste: the benefits of MRBT

This report emphasises the importance of a bridge strategy for residual waste management in the process of the realisation of a circular economy. European pre-treatment obligations have driven improvements in waste management by reducing landfill negative impacts and increasing disposal costs, making reduction, reuse, and recycling more appealing. However, (co-) incineration has taken the lead as a treatment strategy to tackle the use of landfills. The incineration of materials destroys vast amounts of resources, requires the extraction of new primary raw materials, perpetuates a linear economic model, and releases greenhouse gases (GHG) from fossil-based materials. Furthermore, the lack of operational flexibility compels to deliver designed tonnages of mixed waste, so as to ensure the pay-back on anticipated investments. This stands wholly against the achievement of a circular economy, Therefore, there is a need to find a more environmentally conscious waste-management system that is as operationally modular as it is financially and temporally implementable.

As seen in this briefing, Material Recovery and Biological Treatment (MRBT) proves advantageous over incineration and co-incineration. **MRBT is scalable and modular, making it adaptable to varying operational capacities and enabling districts to be autonomous in residual waste management. Additionally, MRBT is cost-competitive, quicker to implement, climate-friendly (in that it avoids methane from landfills, while concurrently avoiding the release of fossil CO2, as it would be, instead, with incineration), and operationally flexible.** This flexibility, accommodating growing amounts of clean organics and recyclables, is a significant advantage in aligning with the EU's circular economy goals.

Zero Waste Europe (ZWE) is the European network of communities, local leaders, experts, and change agents working towards the prevention and elimination of waste in our society. We advocate for sustainable systems; for the redesign of our relationship with resources; and for a global shift towards environmental justice, accelerating a just transition towards zero waste for the benefit of people and the planet. www.zerowasteeurope.eu

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