

Urban mining as a sustainable strategy for the management of residual solid waste

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Keywords: recovery, resource, solid waste

The production of waste represents a pressing issue and its sustainable management is being regarded as one of the greatest challenges of this century. Over the years waste handling strategies have moved from landfilling, often performed under uncontrolled conditions, to recycling processes, in order to reduce the environmental footprint of residue disposal.

Although more recently the need to prevent waste production has been pointed out, the relation between consumption patterns and waste production limits the reduction of both amount and hazardousness of waste. This issue is even more serious as it comes along with the depletion of resources aiming at the production of those goods destined to become waste. The level of waste generation is indeed directly related to economic development, rate of industrialization, and public practices (Fazeli *et al.*, 2016).

Therefore the decoupling of prosperity from resource consumption (Sauvè *et al.*, 2016) has been identified as a suitable strategy to promote the decrease of both resource consumption and waste generation, addressing a circular economy approach over the traditional linear one (Preston, 2012; Bonciu, 2014; Ghisellini *et al.*, 2016). In a circular economy, the production of goods is preferably pursued by either the use of by-products or waste recycling rather than by virgin resource consumption, so as to close the loop of material streams (Geng and Doberstein, 2008; Souza, 2013).

The proper implementation of such approach requires the definition of strategies aiming at the extraction of resources from waste for their reuse, recycle and recovery (Cossu, 2013). Although the regulation enforced in most countries worldwide have been promoting the source sorting of waste for recovery purposes, the possibility of extracting further resources from urban material deposits have driven the development of the “urban mining” concept.

Brunner (2011) stated that urban mining refers to the “systematic use of anthropogenic materials from urban areas, which host large stocks of materials in different forms”, useful to be reclaimed in order to pursue resource conservation, environmental protection and economic benefits as well (Gutberlet, 2015).

The strategy of urban mining has been largely applied in landfills, with the aim of recovering materials from the disposed waste as well as of restoring the area used for waste burying (Krook *et al.*, 2012; Wagner and Raymond, 2015; Winterstetter *et al.*, 2015) and, more recently, it has turned to be applied to different kinds of waste deposits.

In Campania Region, urban mining has been proposed to manage the residual waste stored in form of bales in different regional sites.

Waste bales represents the main cumbersome expression of the solid waste management crisis that Campania Region has experienced for more than a decade. In that period, due to administrative difficulties, poor separate collection and substantial shortage of waste processing facilities, the most significant portion of municipal solid waste ended up in the unsorted stream, destined to mechanical and biological treatment plants. The overload of these plants turned into the production of a mechanically sorted rest waste that could not be classified as Refuse Derived Fuel (RDF) and was thus stored in bales (Belgiorno *et al.*, 2003).

Preliminary characterization of this waste showed a significant portion of plastics that can be processed for the recovery of either material or energy, as pointed out in studies reporting similar experiences (Di Maria *et al.*, 2013). However the specific characteristics of waste bales, the chemical-physical and biological processes that this waste has undergone over time represents two of the main challenges in the identification of a sustainable process scheme for their recovery under the concept of urban mining (Belgiorno *et al.*, 2016).

This condition poses the issue of the actual feasibility of urban mining strategies, under both a technical and an economic point of view. Despite the high potential of urban mining strategies, the state of the art of their application is still theoretical (Krook and Baas, 2013). Such aspect limits the identification of applicable systems but opens wide research opportunities for the development of methodology to assess the performance of such activities as well as that of technologies for their sustainable implementation.

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