From urban to landfill mines

In view of a more sustainable urban metabolism, KU Leuven's Dr Peter 'Tom' Jones calls for enhanced landfill mining to unlock the resource potential in Europe's 150,000 to 500,000 landfills

AS highlighted in the Strategic Innovation Plan for the European Innovation Partnership on Raw Materials (2013), the EU urgently requires a comprehensive raw material strategy, which is to be based on three equally important pillars: (1) recycling, (2) substitution, and (3) sustainable primary mining. Leading EU member states have excelled in innovative recycling technologies for freshly produced waste flows, ranging from pre-consumer production scrap, post-consumer urban solid waste, industrial process residues obtained through metal production (tailings, slags etc.) and thermal treatment residues (e.g. bottom and fly ashes).

Urban metabolism

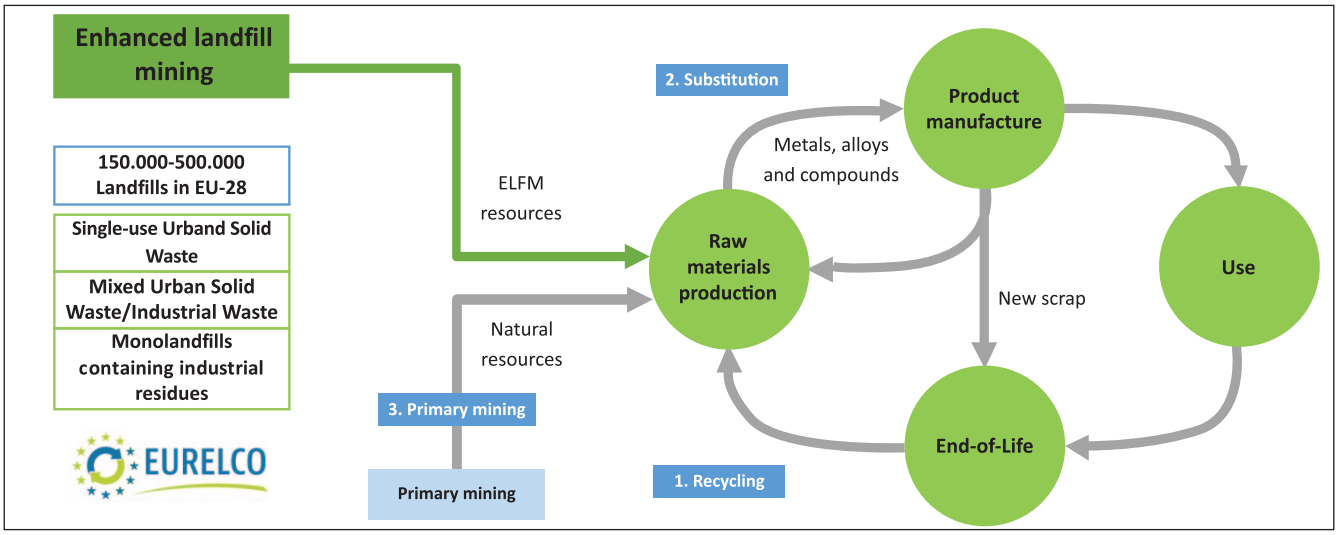
In view of transitioning towards a sustainable and resilient urban metabolism paradigm, the European Commission has called for eco-innovative solutions to prevent waste generation and promote the use of waste as a resource to recycle, reuse and recover raw materials (H2020-WASTE-6a-2015). In doing so it is possible to reduce the negative environmental impacts caused by waste generation in urban and semi-urban environments.

However, what is still strongly overlooked is that, apart from the reuse and recycling of freshly produced urban and industrial waste streams, there is a vast, currently still untapped potential of material stocks available in the 150,000 to 500,000 historic and active landfills in the EU28, many of which are located in urban and semi-urban environments, where they represent a major environmental and health liability.

From threat to opportunity

Based on the EC waste framework and groundwater directives, preventive measures have to be taken for landfills in order to keep pollution from spreading and contaminating the groundwater. However, deploying necessary budgets for old and abandoned landfills is difficult for many member states, especially in cases where environmental and human health risks are not known, often because of limited monitoring. Consequently, for many landfills and surrounding areas, land use has to be restricted due to pollution-related potential risks.

Any more sites do not pose immediate threats, but contribute to a steadily deteriorating groundwater quality and ultimately require landfill remediation. For instance, OVAM, the Flemish public waste agency (Belgium), recently spent €80m of taxpayers' money on the remediation of just five problematic landfills. Knowing that Flanders has more than 2,000 landfills, and the EU28 up to 500,000, it is clear that major cost savings can be achieved in the future by developing eco-friendly, cost-effective enhanced landfill mining (ELFM) technologies and frameworks.



Comprehensive raw materials programme. ELFM adds additional 'postponed' circularity by re-integrating previously landfilled resources into the materials cycle. Figure adapted from C Meskers (Umicore)

Enhanced landfill mining

Enhanced landfill mining, defined as "the integrated valorisation of landfilled waste streams as materials and energy (carriers), using innovative transformation and upcycling technologies and respecting the most stringent social and ecological criteria",[1] is relevant for both single-use urban solid waste landfills, mixed urban solid waste/industrial waste landfills and monolandfills containing industrial residues such as red mud, goethite, phosphogypsum, tailings, and metallurgical slags. In many cases these residues contain significant concentrations of critical metals. With regard to urban solid waste landfills, ELFM involves the complete excavation of the landfilled waste, the separation into different fractions, the preprocessing into directly recyclable fractions and a high-quality refuse-derived fuel, the advanced thermal treatment of the refuse-derived fuel fraction and the upcycling of the subsequent thermal treatment products in clean syngas and low carbon building materials.

In the case of industrial residue landfills ELFM targets the excavation and zero waste valorisation of the residues, which implies both the metal recovery and the subsequent transformation of the metal-free mineral residues into low carbon building materials. Hence, ELFM allows us to transform the EU's landfills, particularly those in urban environments, from a threat and a major (future) cost into a (present) resource recovery opportunity.

ELFM allows us to 're-mine' Europe and should be considered a postponed form of closing-the-loop, injecting additional resource circularity and resilience into the EU's economy. Similarly as for urban mining, enhanced landfill mining of industrial residues helps in shielding the community from foreign export quotas and price fluctuations for critical metals.

Furthermore, the developed ELFM-derived technologies such as two-stage plasma gasification and vitrification (instead of traditional incineration) and inorganic polymer production can also be adopted for fresh streams of urban solid waste and as such contribute to a more sustainable urban metabolism. The same remark is valid for the new metallurgical systems that are developed for ELFM of industrial residues.

The future of ELFM

As primary resources become scarcer and external costs are increasingly being internalised, the possibilities for landfill mining are set to increase. However, to initiate landfill mining in the EU, a paradigm shift is urgently required in which landfills are to be considered resource reservoirs awaiting their valorisation.

Concurrently, public waste agencies need to create the legal frameworks that will allow ELFM to prosper, in harmony with local urban residents living close to the targeted landfills and who need to be integrated right from the start in new ELFM projects. Local job creation, including both high and low skilled jobs, is an asset.

In order to further improve the chances of ELFM, it is important to make the business case of such endeavours less reliant on public subsidies. This can be achieved by promoting radical innovation in ELFM technologies, along the entire value chain, which allow the generation of high added-value products such as clean syngas for conversion into hydrogen or innovative building material products based on inorganic polymer binders.

EURELCO

To this end, the Sustainable Inorganic Management cluster at the KU Leuven (Belgium) has taken the initiative, together with its colleagues of Group Machiels, i-Cleantech Flanders and the OVAM, to establish the European Enhanced Landfill Mining Consortium, which is an open, quadruple helix network that supports the required technological, legal, social, economic, environmental and organisational innovation with respect to enhanced landfill mining.

EURELCO, which received EIP RMC status (European Innovation Partnership Raw Material Commitment), has 46 partners from 12 different EU member states, including many companies, public waste agencies, civil society groups and a host of leading knowledge institutes such as KTH, RWTH Aachen, Montanuniversität Leoben, KU Leuven, University of Padova, VTT and many others and a host of leading knowledge institutes of which most are core members of the winning EIT KIC RawMatTERS Consortium (KTH, RWTH, Montanuniversität Leoben, KU Leuven, University of Padova, VTT, VITO etc.).

The short term goal of EURELCO is to perform cutting-edge research in ELFM technologies, to perform demonstration and co-ordination projects and to disseminate the technological and non-technological features of ELFM to a diversity of audiences.

The vision of EURELCO is that "by 2020, enhanced landfill mining is implemented EU wide as a key component of a resource efficient, circular and low carbon economy. The EU's 150,000 to 500,000 landfills provide for a substantial part of the EU's material, energy and land needs. ELFM has paved the way for breakthrough exploration, separation, transformation and upcycling technologies that are also used for recycling/urban mining of newly produced waste and industrial process residues".

[1] PT Jones *et al.*, *Journal of Cleaner Production,* 55, 2013, 45-55.

KU LEUVEN
SUSTAINABLE INORGANIC MATERIALS MANAGEMENT

Dr Ir Peter 'Tom' Jones
General Co-ordinator EURELCO
Industrial Research Manager KU Leuven
Department Materials Engineering
KU Leuven

tel: +32 (0)486 83 64 94

Peter.jones@mtm.kuleuven.be
www.eurelco.org
http://set.kuleuven.be/mrc/sim2/