Treasure Island

Dr Stuart Wagland of Cranfield University, discusses the university's research into landfill mining and the forming of the European Enhanced Landfill Mining Consortium

The issue of resource security has come to the forefront of the debate over recent years, partly due to considerable concern over the security of supply of so called "critical" materials, with rare earths attracting the greatest attention in the press. Their supply is fundamental to maintain and develop UK and EU economy, and its industries rely on a steady supply of raw materials. There is an increasing scarcity and raising prices of both energy raw materials and other raw materials, such as metals and minerals. This means that the recycling and recovery of these materials from anthropogenic deposits, such as landfills, is of increasing relevance. Europe has somewhere between 150,000 and 500,000 landfill sites, with an estimated 90 percent of them being "non-sanitary", and pre-dating the EU Landfill Directive of 1999.

The UK has around 20,000 historic landfill sites of which only around 4,000 are more recent and are licensed; only a small proportion of these are still in use. Thus historical background makes the numerous old waste dumps as possible sources of critical and secondary raw materials (CRM and SRM). However, to date there is no inventory of SRM and CRM present in EU and UK landfills currently available. Moreover, best management practices to recover SRM from landfill activities are inefficient.

Our research work has shown the extent to which landfill sites are an unrecognised source of resources, new pockets and veins of valuable materials – and the ways in which landfill mining can become a commercially viable option in support of both the sustainability agenda and in land reclamation.

It will ensure that a large range of industries can rely on a steady supply of raw materials and have a sustainable future. An increased scarcity has meant rising prices among energy-producing and other raw materials, such as metals and minerals. This puts pressure on businesses for their survival. Many of the metals in landfill therefore constitute valuable and scarce natural resources.

Arsenic (which is an essential part of the production of transistors and LEDs) is predicted to run out sometime in the next five to 50 years, if consumption continues at the present rate. Nickel (used for anything involving stainless steel) and platinum group metals (used in catalytic converters, fertilisers etc) are also identified as critical materials to the UK economy at risk of depletion in the Resource Security Action Plan (RSAP). However, despite the increasing demand, none of this supply is supported by recycling. This is due to the high cost of recovery from low concentrations when compared to conventional mining.

In this context the recycling and recovery of these kinds of materials from the man-made "anthropogenic" deposits like landfills is increasingly relevant, but up to this point authorities haven't had any grasp on the extent and potential of materials for "mining", which is the all-important basis for decisions to be made on the viability of investment into the approach.

Soil samples taken from 20 metres down from across the four sites

Commercial Opportunity

MY RESEARCH, alongside Dr Frederic Coulon and Dr Diogo Martins Gomes, is the first of its kind. We analysed 55 samples collected between five and 30 metres deep in four different UK landfill sites. These samples were carefully prepared to remove larger objects, and then analysed for the content. We estimated that, just in the four examples studied, the sites contained £104m in platinum group metals; £280m in aluminium and copper; £10m in lithium and £6.4m in neodymium. More value would be available from the larger metal items and plastics.

Mining solely for metals themselves is not expected to be financially viable, given the extent of the recovery operations involved. However, other opportunities exist that together form the concept of "enhanced landfill mining". Waste-derived fuels from excavated materials have the potential to be highly energetic. The energy potential is comparable to the levels of energy of refuse-derived fuels (RDF) produced from non-landfilled wastes.

As an example of the potential, in 2015 almost 3m tonnes of RDF were exported from the UK. Ultimately, the mining and recovery approach leads to a further commercial opportunity in the land itself – reclaimed and the soil remediated – making it available again for agriculture or other forms of development. Abandoned landfill sites present environmental and human health risks that can involve large taxpayer investments to clear up. In Belgium, in recent years, it took €80m to deal with the impact of five landfill sites on their immediate environment and groundwater quality. It's been estimated, based on average amounts of materials per landfill in the EU, that landfills could provide up to five percent of the total needs of Europe for non-energy, non-food materials and minerals for the next 25 years.

55 samples were collected across four different UK landfill sites

Nonetheless, there are many challenges in enhanced landfill mining, which means that further research and development is needed before the full potential is realised. We need to understand more about each of the stages involved: the exploration, separation, transformation and upcycling technologies, and how these can best be applied in dealing with the differing urban and industrial landfill sites. There are also policy challenges in terms of creating the legal frameworks that allow for enhanced landfill mining, working in close co-operation with local communities affected by the works.

European Backing

CONCERTED ACTION is underway to overcome these challenges and to make landfill mining a significant part of the future of waste strategies. A large consortium of research institutes, including Cranfield, alongside public bodies and private companies, has formed the European Enhanced Landfill Mining Consortium (EURELCO). The aim of EURELCO is for enhanced landfill mining to be implemented EU-wide as a key component of a resource efficient, circular and low-carbon economy by 2020.

The potential of enhanced landfill mining was presented to the European Parliament last year and has received backing from the European Horizon 2020 fund for a new project – Smart Ground. This work will develop an extensive understanding of the SRM available in landfills across Europe. Smart Ground will open up understanding and the opportunity for markets in SRM, providing a clear picture of the value of landfill contents and the barriers to recovery.

Most importantly, there needs to be a shift in attitudes to our landfill sites, from "dump" to "mine", in order to gain the level of government and public commitment needed to go forward. Taking enhanced landfill mining seriously will mean turning a current threat, in terms of the environment and in the rising costs of scarce resources, into the opportunity for a new and sustainable industry.

The extent of the success of enhanced landfill mining will be dependent on shifting the activity into the business sector and not relying solely on public subsidies. Some of the innovative technologies involved have the potential for further commercialisation to produce high added-value products such as hydrogen, and for upcycling waste into building material products. ■

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