Until relatively recently, the predominant form of waste disposal in Europe has been landfill. Across the EU, the legacy of that is an estimated 150,000 to 500,000 historic landfill sites – many not built to today’s sanitary standards. On 31 August this year, a four-year EU-funded project investigating the potential to recover materials, energy and land from these sites concluded.

By Ben Messenger
Launched back in 2016, the four-year NEW-MINE research project, led by KU Leuven Institute for Sustainable Metals and Minerals, was tasked with looking into the possibilities of Enhanced Landfill Mining (ELFM). With project partners including German recycling equipment manufacturer STADLER, the EU-funded research explored the potential for recovering materials for recycling from closed landfill sites, as well as waste-derived fuel, all while recovering increasingly valuable land for reuse.

In its recently published report highlighting its findings, the NEW-MINE project explains that the state of the art for dealing with old landfill sites is currently ‘landfill aftercare’, which includes the collection and treatment of landfill gas and leachate, and also advanced methods such as focused irrigation. This incurs ongoing costs which should be covered from accruals taken from gate fees during the site’s years of operation. However, for many old landfills no accruals for landfill aftercare have been created, which results in a ‘Do-nothing’ scenario.

It is estimated that some 90% of closed landfill sites across Europe are non-sanitary, predating the EU Landfill Directive of 1999. These older landfills tend to be filled with municipal solid waste (MSW) and often lack any environmental protection technology. In order to avoid future environmental and health problems, many of these landfills will soon require expensive remediation measures. In some

FACTS

OVER 10,000 LANDFILLS IN FLOOD-PRONE AREAS
A particularly worrying and fairly new risk originates from the effects of accelerating climate change, which is resulting in rising seawater levels and an increase of flooding, erosion and heavy rainfalls.

Of the 500,000 landfills and extractive waste deposits in the EU, it is estimated that more than 10,000 sites are in areas already at risk of flooding. Clearly, a ‘Do-nothing’ approach is not the best landfill management scenario for these sites.
cases, contaminated sites have resulted from disposal of MSW and require remediation. ‘Classic remediation’ costs in the EU-28 account for between €100 billion and €1 trillion.

The NEW-MINE project was founded on the premise that while the situation might appear bleak, it does present an exciting opportunity for a combined resource-recovery and remediation strategy. ELFM has the potential to provide a solution that could dramatically reduce future remediation costs and reclaim valuable land while unlocking precious resources.

THE CASE FOR MINING
The project received funding from Horizon 2020, the European Union’s EU Framework Programme for Research and Innovation, and involves eight European universities as well as STADLER and other companies from the private sector. Fifteen PhD students were tasked with researching new technologies and testing them in four technical work packages that follow a value chain approach, from “Innovative landfill exploration and mechanical processing” to “Solar/Plasma/Hybrid thermochemical conversion” and “Advanced upcycling”. The fourth work package applies multi-criteria assessment methods to compare combined resource-recovery/remediation methods, that is ELFM, with the ‘Do-nothing’, ‘Classic remediation’ and ‘Classic landfill mining with (co-)incineration’ approaches.

The idea of mining old landfills is nothing new. The concept has been bounced around for many years, but technical and commercial realities have prevented its widespread adoption.

“In classic landfill mining, the focus is on reducing the volume of waste, for example through incineration and the recovery of land, while the production of recyclates is in general limited,” explains Dr Lieven Machiels, Science & Technology Coordinator of the project at the KU Leuven Institute for Sustainable Metals and Minerals. “In the NEW-MINE project, we followed an ELFM approach aiming at a maximal recovery of resources. Instead of burning the light fraction, we produce a Refuse Derived Fuel (RDF), which is thermally converted to produce a syngas and a vitrified residue. The syngas can be further upcycled to produce methane or hydrogen, while the vitrified residue can be used for producing cement and construction materials.”

“We consider Enhanced Landfill Mining the missing link to a Circular Economy,” he continues. “The Circular Economy Action Plan of the European Green Deal focuses on a ‘sustainable products’ policy that prioritises reducing and reusing materials before actually recycling them, moving up the waste hierarchy. Nevertheless, what is not yet addressed is the question of what Europe and other countries in the world will do with the vast amounts of industrial and consumer waste that have been disposed of in waste dumps and landfills over the past 100 years. In this context, ELFM has been proposed as an out-of-the-box approach to address how we can deal with the waste of the past, irrespective of the urgent need to avoid new waste creation and disposal in the future.”

However, to achieve such a result requires some serious investigation into the
nature of the materials involved, and the methods that can best be used to separate them for optimal recovery – either energy or materials.

STADLER’S MECHANICAL KNOWHOW
Knowing that the challenge of successfully sorting materials mined from historic landfill sites would greatly benefit from the knowledge and experience of the private sector, RWTH Aachen University, one of the project’s partners, invited STADLER to participate.

“We were contacted by Aachen in 2015 about the possibility of a landfill mining project and said yes, we would like to get involved with that, so we’ve been involved right from the start,” Ulrich Sigmund, Head of R&D at STADLER, tells WMW. “Basically, it’s different from MRF sorting because it’s wet, it could be harmful and it’s very heavy. It looks like soil, but with films in it.”

The company played an important role in the first work package, dedicated to mechanical processing. The main goal was to identify ways of improving the quality of the fractions in order to produce RDF, which has a variety of applications. Another important goal was to research uses for fine fraction (<20 mm), which accounts for more than 50% of the waste in general landfill mining and currently has no utilisation. The project showed that further mechanical separation of fine fraction can produce sand for use as an aggregate in the construction sector. The light fraction can also be used in a thermo-valorisation process.

STADLER also contributed to the training programme associated with the project with a course on “Automated...
sorting technology for complex waste”, which was held during the second NEW-MINE Network Event for the 15 participating PhD researchers.

“There’s only around 2% of the material that is metals which can be recycled,” explains Sigmund. “Then there’s roughly 8% of plastics for energy recovery. Around 50% is inert, a lot is soil, or fines from the metals that have deteriorated. In the beginning there was the thought that there would be more material to recover, but in the end, it turns out to be around 10%. There’s another 20% that could be used for construction, but 70% seems to be quite soily material, and at the moment that has to be landfilled again."

Adding to the difficulty of sorting, it wasn’t possible to truck the material around to off-site sorting facilities from a legal standpoint. Therefore, STADLER installed a mechanical sorting system on-site on a temporary concrete foundation in the landfill.

GOING BALLISTIC

The theoretical research on mechanical processing was tested in real conditions in the Mont-Saint-Guibert landfill in Belgium. The landfill waste was excavated and processed.

“An STT6000 Ballistic Separator was used in the first step of the mechanical treatment for the recovery of RDF and other recoverables, such as metals and inert materials. The machine separated the output in three fractions – fines, rolling fraction and flat fraction – which were then treated separately in order to investigate further recycling possibilities,” says Sigmund.

Cristina Garcia Lopez, one of the NEW-MINE project’s researchers, adds: “Since the landfill waste is a very complex and heterogeneous material due to the amount of impurities, the ballistic separator provided us with the opportunity to dose the unsorted and unshredded excavated waste into three different material flows: potential RDF, 3D fraction and fines. It also allowed us to sort the landfill waste in its original size without shredding, avoiding the loss of small particles in the fine fraction – which required fewer steps. Besides, the great infeed of the ballistic STT6000 (150 t/h, depending on the density of the material) made it quite interesting since the amount of waste buried in landfills is considerably high while the general mechanical processing capacity is really low compared to the excavation capacity.”

Landfills present a particular challenge, as Dr Machiels suggests: “The level of moisture of landfilled waste is much higher than in fresh waste, and the waste is strongly degraded. Work package 1 analysed how this material behaves in all steps of the mechanical separation process and what the properties are of the different output fractions. This research was new, and therefore its results are important for the future of landfill mining.”

Dr. mont. Bastian Küppers, also a researcher in the NEW-MINE project, adds: “The continuous mechanical treatment of the landfill is extremely challenging, as the high water content leads to blockages in the process chain and reduces the performance of plant and machinery. This is especially true for fine fractions.”
However, according to Sigmund, the STADLER Ballistic Separator has overcome all the challenges, showing that it can perform in these difficult conditions and confirming the feasibility of the project: “The high moisture value of the material was very challenging because the input was composed of pieces of rock and lumps of earth of up to 100 kg,” he says.

Christian Nordmann, Deputy Head of Research and Development at STADLER, who worked actively on the tests in Belgium, adds: “The machine is very robust due to the two drives and central lubrication during operation. Also, the bearings are very well sealed, so the machine can operate outdoors. This enables the STT6000 to deal with the challenges found in the excavated landfill material, such as high moisture, dust and impact. In the tests we were able to model the material separation, including mass distributions and material parameters of the derived fractions.”

“The tests showed that a new approach of starting a recycling process with a separation in three fractions is possible. This saves wear and energy compared to standard processes with a shredder/screen combination,” concludes Ulrich Sigmund. “It doesn’t pay for itself from a commercial standpoint; it depends how much you prize the environmental benefits, and of course land reclamation. If you have a landfill close to a megacity, where the land prices are very high, that could make a business case.”

“STADLER’s Ballistic Separator has proven to be very robust and useful for loosening up, separating and thus preconditioning the material for treatment.”

Dr mont. Bastian Küppers, a researcher for the NEW-MINE project

ACI ENTECH
ACI, Sustainability Creator
Solid Waste Treatment Solution Provider

www.acientech.com

Air Shifter
Air Blowing System to Separate Light Material from Heavy Material

Air Ballistic Separator
Great Combination of Air Shifter and Ballistic Separator

Ballistic Separator
Multi-Sorting System Separating Mixed Wastes into Three (3) Categories

Tel. 82-2-6213-6210 E-mail. info@acientech.com