**SMART** data collection and inteGRation platform to enhance availability and accessibility of data and information in the EU territory on SecoNDary Raw Materials

Landfill Mining overview
How many landfills in the EU-28?

- Sufalnet4EU: > 150,000 landfills
- Hogland et al, Proc. ELFM I, 2010: 350,000 – 500,000 landfills and dumps
- Bottom-up questionnaire EURELCO: 500,000 figure is most probably an underestimate

What kind of landfills?

- Europe’s landfills vary in size, depth, type, degree and monitoring level
- Single Use Urban Solid Waste (USW) Landfills, Mixed USW/IW Landfills, mono landfills containing one particular Industrial Waste residue
- Sanitary (managed) landfills (cf. Landfill Directive) versus unmanaged “non-sanitary” landfills and even waste dumps
- Publicly owned versus privately owned
Present situation on MSW: landfilling and incineration still main practice
The objective of the Landfill Directive is to prevent or reduce as far as possible negative effects on the environment, in particular on surface water, groundwater, soil, air, and on human health from the landfilling of waste by introducing stringent technical requirements for waste and landfills.

The Landfill Directive defines the different categories of waste (municipal waste, hazardous waste, non-hazardous waste and inert waste) and applies to all landfills, defined as waste disposal sites for the deposit of waste onto or into land. Landfills are divided into three classes:

- Landfills for hazardous waste;
- Landfills for non-hazardous waste;
- Landfills for inert waste
EU Waste Management is governed by the EU Waste Hierarchy (Ladder of Lansink)

Key attention for climbing the ladder for freshly created Urban Solid Waste and Industrial Waste *FLOWS*, leading to:

- Improved recycling technologies
- Incineration RUSW with energy recovery
- Phasing out landfilling
- Make sure that remaining landfilling is safe!
EU waste management: A global perspective

The Waste Hierarchy

This infographic shows the state of waste management in different parts of the world by looking at selected indicators of waste reduction, recycling, energy recovery, and disposal.
Landfill Directive has been instrumental in improving safety of landfilling operations in many EU Member States. However, many questions remain:

- What about the historic legacy of landfills that were created prior to the Landfill Directive (1999)?
- Are these landfills safe?
- Is remediation required?
- What is the cost of remediation?
- Do they offer resource recovery opportunities?
Landfills in Europe
Key messages:

• >90% of EU’s landfills are essentially “non-sanitary landfills”, preceding the Landfill Directive

• They will need remediation – estimated “classic remediation” cost for EU-28 is between €0,1 and 1 trillion

BUT...

• These landfills constitute enormous resource stocks

• ELFM, combined with remediation, can deliver materials, energy and land, while drastically reducing remediation costs
What is enhanced landfill mining?

The integrated valorisation of (historic and/or future) landfilled waste streams as both materials (Waste-to-Material) and energy (Waste-to-Energy), using innovative transformation technologies and respecting the most stringent social and ecological criteria.”

Enhanced Landfill Mining in view of multiple resource recovery: a critical review (Jones et al., JCLEPRO, 2013)
Need to consider the whole picture

➢ Waste-to-Energy
➢ Waste-to-Material
➢ Chemical feedstock
➢ Land restoration

Integration of landfill mining in the circular economy
Modified from Ellen Macarthur Foundation system diagram
ELFM: Definition relevant for MSW and industrial residues landfills containing critical metals

Source: Binnemans et al., JCLEPRO, 2014
ELFM with respect to other scenarios
Industrial residue landfills
Barriers for ELFM – Policy aspects

The landfill is stuck in a dump regime

- EU Landfill Directive strongly advocates isolation, control, final closure and post-monitoring
- This perception of landfills as hazardous, end stations for obsolete materials displays clear signs of path-dependency and lock-in
- The fact that ELFM is not part of EU policy and regulatory frameworks causes multiple challenges and uncertainties
- Such uncertainties regarding the market rules make it difficult for actors to foresee the outcome of their investments
- Most of the benefits of landfill mining only occur on the societal level = key policy challenge coupling ELFM with remediation needs can offer a way forward!
Impact of ELFM at EU-scale (see Jones et al., 2013)

**Economic benefits**

- **Avoidance of landfill remediation costs**: \(0,1-1\) trillion € (if ELFM concept is used for all EU-landfills)
  - A new resource recovery economy, with significant short, medium and long term potential for EU SMEs in EU-27 and in the rest of the world: \(\text{CH}_4\) extraction *(in situ)*; Organic based materials (WtM or WtE) *(ex situ)*; Metals *(ex situ and/or in situ)*; Materials for building and construction *(ex situ)*

- **Recovery of valuable land** *(in situ or ex situ)*
Impact of ELFM at EU-scale (see Jones et al., 2013)

Strategic benefits through resource recovery

• **Improve EU’s materials autonomy**
  - Reducing pressure on primary raw materials (fossil fuels and non-energy raw materials)
  - Fostering the use of secondary raw materials

• **Improve EU’s energy autonomy**
  - Contributing to EU’s renewable energy target through accelerated CH$_4$ uptake through in situ LFM: **7 million TOE ~3% of the EU-27 renewable energy target for 2020**
  - Contributing to EU’s renewable energy target (WtE from SRF (mixed organic) from ex situ LFM: an additional **0,4-1,1 million TOE**)
Health and environment

- Lower the EU’s carbon footprint (benchmark with direct EU $\text{CO}_2(\text{eq})$ emissions: $4600$ Mtonne $\text{CO}_2(\text{eq})$/year):
  - Avoided $\text{CO}_2(\text{eq})$ emissions due to in situ $\text{CH}_4$ mining of $112 – 139$ Mtonne/year;
  - Avoided $\text{CO}_2(\text{eq})$ emissions due to net carbon balance, from a full EU-27 ex situ LFM approach (versus in situ only approach, for $150.000-500.000$ landfills): extra $15 - 75$ Mtonne CO2(eq)/year
  - Use of CO2 in horticulture

- Land reclamation ( >2800 - 6000 km$^2$, nature-urban-industrial purposes)
  - Avoiding future human health and environmental issues due
to landfill pollution problems
  - Reducing environmental & health impact associated with
  - primary mining of energy and non-energy materials
Impact of ELFM at EU-scale (see Jones et al., 2013)

Social benefits

- Creation of new jobs associated with the start-up of new, SME-driven markets:
  - Up to 300 FTE new jobs for the Remo landfill site (ex situ mining)
  - Up to 240,000-800,000 new jobs in EU-27 (for full implementation of ELFM framework)
On-going work: SMART GROUND project

This project has received funding from the European Union’s Horizon 2020 Research and Innovation Programme under Grant Agreement No 641988
Main objective of SMART GROUND

Improving the availability & accessibility of data and information on Secondary Raw Materials from both **URBAN LANDFILLS** and **MINING SITES** through a set of activities to integrate all the data from existing sources and new information retrieved with time progress- in a single EU database.

Web-based portal

Automated report generation & visualisation
Summary: let’s turn the landfill into an opportunity

- 90% of Europe’s 500,000 + landfills are non-sanitary landfills for which the Landfill Directive does not offer a solution

- Dedicated inventory exercises based on log books, geophysical studies, drillings and economic assessments are required in order to obtain better data for EU-28

- ELFM requires a paradigm shift: landfills need to be taken out of the dump regime to be re-considered as “resource reservoirs awaiting valorisation”

- ELFM can be combined with remediation, drastically lowering overall costs

- ELFM triggers technological innovation (circular economy framework) and leads to local job creation

- Private businesses are ready but need stable frameworks