Multi criteria assessment of resource recovery through enhanced landfill mining (ELFM)

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This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon 2020 under Grant Agreement No 721185
WP4 in the NEW MINE project
Goal of the presentation

- Enhanced landfill mining (ELFM)
- The role of Multi Criteria Assessment (MCA) in decision making:
  1. Which landfills can be mined?
  2. How to set up ELFM projects?
  3. What is the role of market and policy interventions?
From landfill remediation to ELFM

Landfill remediation

Land reclamaton

Landfill mining (LFM)

Metals

Total waste 100.0 [%]

Re-landfill 98 [%] 90.3 [%]

Enhanced landfill mining (ELFM)

Energy

Total waste 100.0 [%]

Re-landfill 93 [%] 92.9 [%]

Aggregates & construction materials
Enhanced Landfill Mining

“the safe conditioning, excavation and integrated valorisation of landfilled waste streams as both materials (Waste-to-Material, WtM) and energy (Waste-to-Energy, WtE), using innovative transformation technologies and respecting the most stringent social and ecological criteria” (Jones et al., 2013)
Drivers for ELFM

- Environmental protection
- Recovery of resources and land
- Societal benefits

Mont Saint Guibert landfill (2017)
The Multi Criteria Assessment

**Environment**
- Life cycle assessment (LCA)
- Risk assessment (RA)

**Society**
- Social life cycle assessment (S-LCA)

**Economy**
- Techno-economic assessment (TEA)
- Life cycle costing (LCC)
The Multi Criteria Assessment - Objectives
Overview of an ELFM project

- **Recovery of land**: Material recycling and sales
- **Environmental protection**: Environmental protection + Avoided aftercare/remediation
- **ELFM support**: Minimization of waste re-landfilling
- **Mitigation of risks to HHE**: Recovered landfill voidspace

**COSTS and IMPACTS**

- **Energy Recovery and sales**
- **Material recycling and sales**

**BENEFITS and REVENUES**

- **Recovered landfill voidspace**
- **Environmental protection**
- **ELFM support**
- **Mitigation of risks to HHE**
The technical and organizational aspects of ELFM

System-level conditions drive the main costs and revenues:

- NPV <0 (80% cases)
- Main costs
  - Treatment and disposal of secondary materials
- Main revenues
  - Avoided landfill management costs
  - Material and land/landfill void space recovery
I suggest to delete this. The content will be added to slide 20, so all the econ results are there.

Also, I think it is better to introduce the concept of site, project, and system-level factors—as in the next slide.

Author: 5/02/2020
Critical factors

**SITE-LEVEL**
- Waste composition
- Landfill location
- Landfill reference case
- Quality standards
- Safety regulations

**PROJECT-LEVEL**
- Technology
- Quality
- Market-acceptance
- Logistics
- Costs: energy, processing, investment, O&M, etc.,
- Land recovery
- Avoided impacts
- Stakeholder involvement
- Investment incentives

**SYSTEM-LEVEL**
- Background systems
- Transportation
- Financial effects
- Materials and energy prices
- Legal, institutional, organizational, and societal structures
- Public acceptance
Summary of the critical factors

- Waste and landfill types
- Technology availability and choice
- Project acceptance
- Landfill aftercare and remediation
- Markets
- Regulations
How to account for factor variability in the feasibility assessment of ELFM projects?
Critical performance factors in the NEW MINE project

- Humidity
- Waste composition
- Particle size distribution
- Throughput
- Quality

- RDF composition
- Gasifying agent
- Technology

- Ash composition
- Quantity
- Quality
Multiple scenario analysis for the integrated assessment of ELFM

- Landfill waste
  - >90 mm
  - >30 mm
  - >4.5 mm
  - incineration
  - pyrolysis
  - gasification

- Refuse Derived Fuel (RDF)
- Solar/Plasma/ Hybrid thermochemical conversion
- Slags and ashes*

- Landfill
- aggregates
- Porous material

- Exploration and Excavation
- Unsorted, excavated materials
- Preprocessing & material recovery

- Advanced upcycling
- Quality assurance and upcycling technologies
Technology choices and resource recovery potential

Extent of separation and sorting process:

- **>90 mm**: 79.6% to landfill
- **>30 mm**: 62.4% to landfill
- **>4.5 mm**: 43.8% to landfill
Environmental and economic results
System-level factors are generically critical for LFM economics. Hence, it should primarily guide site prioritization and project design.

- Main costs: Waste treatment and disposal
- Main revenues (indirect): Avoided costs for aftercare and remediation

**High income and advanced waste management systems**

- Maximization of material valorization. **✗**
- BUT motivated to decrease re-landfilling
- Small landfills (low mass/area) are preferred **✓**

**Low income and lenient waste management standards**

- Maximization of material valorization. **✓**
- BECAUSE treatment & disposal costs are already low
- Landfills with high recoverable materials **✓**
Policy interventions required

- Lower re-deposition costs and taxes
- Intensification of aftercare and remediation requirements.
- Break up current market structures
- Economic instruments aiming to internalize other benefits into the project economy, if motivated from a societal perspective.
A2  Can come after slide 20. OR slide 20 and 21 be combined?

Author; 5/02/2020
Possible interventions and policy measures

- Lower re-deposition costs
- Intensification of aftercare and remediation requirements.
- Subsidizing ELFM directly or indirect (e.g. secondary raw materials, green energy, etc.)
- Break up current market structures
- Private-public partnerships (PPPs)
- Bans, caps, standards and norms, and quotas
The role of policy and market interventions

- Institutional and governmental actors want to avoid to subsidize ELFM
- Industrial actors have a need for investment support

Goal is not to find a “best” solution but rather to present comprehensive information for stakeholders in the results of the societal assessment.

Socio-economic and socio-environmental externalities have to be internalized into ELFM processes and business models.

Potential miss out of societal benefits or unforeseen societal costs

Integration through mixed (qualitative and quantitative) approach and the development of stakeholder archetypes
Conclusions

Which landfills to address?
- High costs of aftercare and remediation
- High fraction of recoverable and biodegradable
- High value of land and landfill void space
- Coal-based energy mix

How to select processing and sorting technologies?
- Waste characterization
- Technology choices and efficiencies for excavated waste
- Technology readiness level (TRL)

Role of market and policy interventions?
- Lower disposal costs and taxes
- Market structure and prices
Thank you very much for your attention!

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