LANDFILL MINING – A CONTRIBUTION TO CONSERVATION OF NATURAL RESOURCES?

Sebastian Wanka, Klaus Fricke, Kai Münnich, Anton Zeiner
Motivation - Landfill Mining

- Protection of waters
- Climate protection
- Lifetime extension of landfill
- Recycling of land area
- Resource extraction
Motivation - Landfill Mining

Amount of recycleable fractions provided by MSW landfills

**Germany:**

since 1975: approx. 2.5 billion t MSW with demolition and commercial waste

**World wide:**

since 1975: approx. 60 billion t

Sources:
2) MSW UNEP = 0.28 Mg /cap./a)
Composition of Landfill Waste by Waste Groups

- Minerals: 70%
- Calorific fraction: 22%
- Organics: 30%
- Metals: 4%

Working hypothesis

Motivation - Landfill Mining
Motivation - Landfill Mining

Resource Potential in Landfills – Germany
Landfilled waste since 1975:

• 250 Mio. t calorific fraction on basis of coal_{equ.} resp. Oil_{equ.}
• 1,20 Mio. t copper scrap
• 0,50 Mio. t aluminium scrap

Focus

Fine fraction (< 20mm, represents with 50 – 70% b.w. the largest fraction)

• potentially organic components which can substitute natural resources, e.g. Biogas
• preparation of minerals for the use as construction material
• phosphate as fertilizer
• metals
Motivation - Landfill Mining

Resource Potential Compared to „One“ Annual Need - Germany

<table>
<thead>
<tr>
<th>Material</th>
<th>Potential [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al-scrap</td>
<td>54</td>
</tr>
<tr>
<td>Primary energy</td>
<td>55</td>
</tr>
<tr>
<td>Iron</td>
<td>124</td>
</tr>
<tr>
<td>Copper</td>
<td>142</td>
</tr>
<tr>
<td>Phosphor</td>
<td>287</td>
</tr>
</tbody>
</table>

Sources: Rettenberger 2009; Franke, 2012; Gäth 2012, Fricke 2012
## Motivation - Landfill Mining

<table>
<thead>
<tr>
<th>Materials</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastics</td>
<td>Refuse derived fuel</td>
</tr>
<tr>
<td>Wood</td>
<td>Biogas</td>
</tr>
<tr>
<td>Metal scrap</td>
<td>construction material</td>
</tr>
</tbody>
</table>

Sources: Gölsch, 2006
The r³ Joint – Research Project „TÖNSLM“

Aided by:

- Federal Ministry of Education and Research

Runtime: 2012 - 2015

Companies:

- Tönsmeier Dienstleistung GmbH & Co. KG
- AML (Kreis Minden-Lübbecke)
- IFEU / Öko Institut

Universities

- Technische Universität Braunschweig
- Technische Universität Clausthal
- RWTH Aachen
The r³ Joint – Research Project „TÜNSLM“

Topics of Investigation

- Potentials (resources, raw materials)
- Development of technical concepts for excavation and classification
- Development of products generated from LM
- Economical and ecological aspects
- Legal requirements
- Acceptance
- Measures for work safety
The r³ Joint – Research Project „TÜNSLM“

The Landfill - Pohlsche Heide
Landfill for municipal solid waste and commercial waste

Section 1       :   1989 – 1990
Section 1 + 3 :   1990 – 1995
Section 2       :   1996 – 2005
Process Steps of Landfill Mining (LFM)

1. **Test drillings** → waste composition, leachate situation, aeration

2. **Excavation** → 3 Campaigns, each with about 2.600 m³/trench

3. **Separation** → size reducing, screening, ballistic separator

4. **Treatment** → minerals, metals, organics, plastics
   lab. Scale / industrial scale

5. **Disposal/ re-disposal of the remainder**
The r³ Joint – Research Project „TÖNSLM“

Treatment (industrial scale)

- Thermal treatment (heating power plant Minden)
- Mechanical biological treatment (Waste Management Center Minden)
- Sorting, wet (MBT Göttingen)
- Sorting, dry (Mechanical Sorting Plant for lightweight Packaging, Porta Westfalica)
The r³ Joint – Research Project „TÖNSLM“

Treatment (laboratory scale)

- Development of Products
- Treatment (wet, dry)
  → Mineral recovery
  → Energy recovery
- Pyrolysis
- Purification
- Evaluation of different technologies for incineration
Evaluation by UMBERTO

→ new tools have to be developed to describe all processes and interactions

To develop the model, data from literature and own data from the Oeko-Institut data are used.

To refine the model, data from literature and own data will be replaced by data from the landfill “Pohlsche Heide”.

Reference scenario:

The waste from the landfill is not excavated. LFG and leachate are collected and treated.
Ecological and economical evaluation of landfill mining projects

Scenario 1: Incineration, complete

Stabilization & Excavation → Incineration → Treatment slags → Treatment metals → Metals → Energy

Mineral materials

Sources: Treatment processes and material flow in the TÖNSLM project (Theis and Knappe, 2013)
Ecological and economical evaluation of landfill mining projects

Scenario 2: recycling, maximal

Stabilization/Excavation → mechanical treatment

- Sorting
  - > 60 mm → Treat. inert. Mat.
  - < 60 mm → Treatment fine material

Treatment fine material → Landfill

- > 60 mm → Treat. inert. Mat.
- < 60 mm → Treat. metals → Incineration

Sources: Treatment processes and material flow in the TÖNSLM project (Theis and Knappe, 2013)
Ecological and economical evaluation of landfill mining projects

Scenario 3: recycling, minimal

Stabilization/Excavation

- Mechanical treatment
  - Sorting
    - > 60 mm
    - < 60 mm
  - Biological treatment

- Treat. inert. Mat.
- Treat. plastics
- Treat. metals
- Incineration
- Landfill
- Mineral materials
- Plastic granulate
- Metals
- Energy

Sources: Treatment processes and material flow in the TÖNSLM project (Theis and Knappe, 2013)
Ecological and economical evaluation of landfill mining projects

Source: Evaluation of greenhouse effects of landfill mining for different scenarios (Theis and Knappe, 2013)
Conclusions

• Under only ecological aspects landfill mining with the aim to bring as much as possible waste material back into material cycle is certainly discussed controversially.

• At the moment only economical aspects cannot be the main motivation for landfill mining, but the revenues will reduce the total costs for landfill mining considerably.

• Although recycling measures and landfill mining alone can of course not prevent the shortage of resources on the long-term, they form an important module for the future supply of resources.

• The aim of the project is to generate a universally valid guideline for such projects.
it is not the question of whether….

 .......... it´s the question of when