Landfill mining potential in Spain and review of preliminary experiences

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OUTLINE

- Goals
- Waste generation in Spain
- Historical data on landfilling
- Composition within the landfills
- Number and type of landfills
- Estimation of strategic materials
- Emissions potentially avoidable
- Other aspects of the research

GOALS

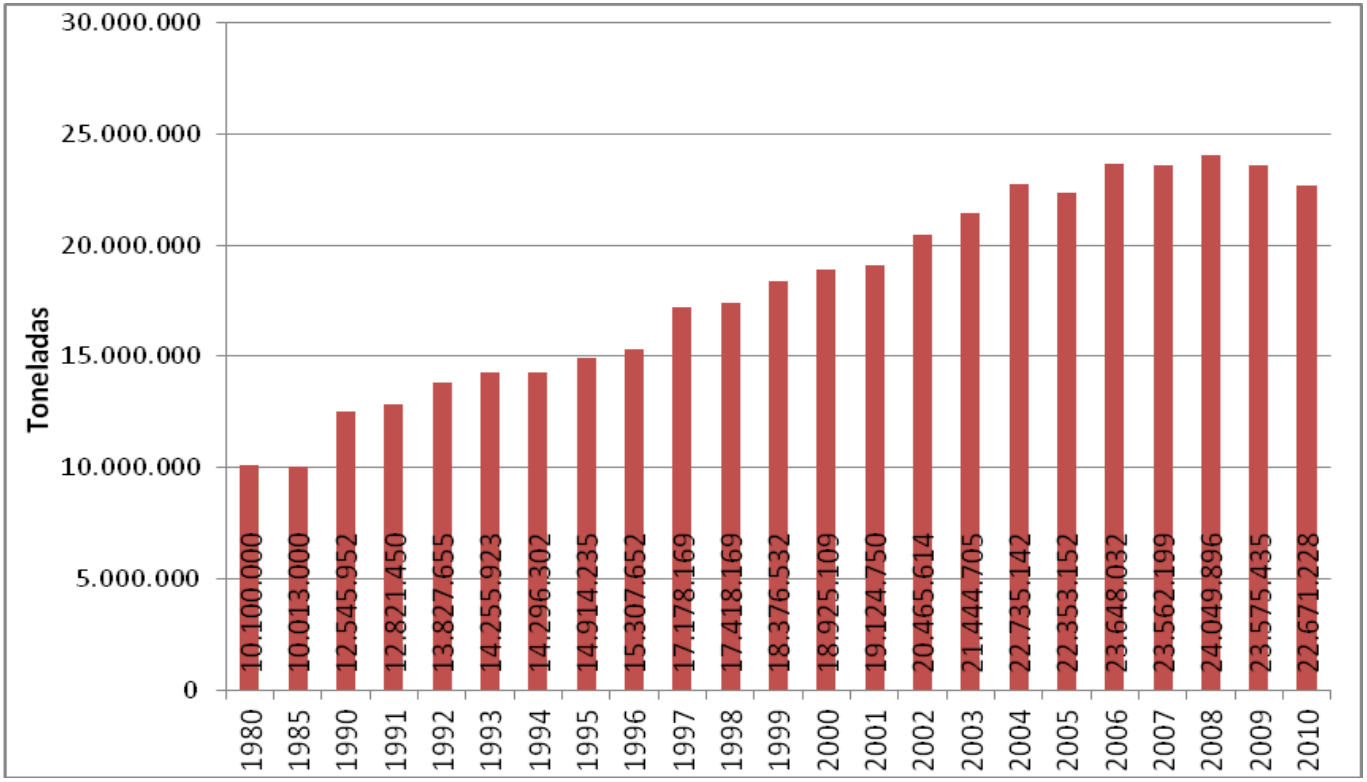
During 2011-2012 a research on landfill mining was conducted in Spain, which concluded in this report: Puig Ventosa, I. (Coord.), Calaf Forn, M., Jofra Sora, M. “Minería urbana: extracción de recursos de los vertederos”. Fundación Mapfre - Ayuda a la Investigación 2011. 2013. http://bit.ly/1ixUDoV

The main goal of the report was to assess the viability of conducting landfill mining in Spanish landfills. To this end, other objectives were:

- To estimate the amount of waste with potential for being valorised currently deposited in landfills.
- To assess the maturity of the different existent technologies for the extraction of resources.
- To identify which criteria landfills should comply with to be adequate candidates for landfill mining.
- To analyse how landfill mining could contribute to reduce the Spanish dependency on imports of certain raw materials.
- To analyse to what extend landfill mining could contribute to the Spanish international commitments in relation to climate change.

WASTE GENERATION IN SPAIN

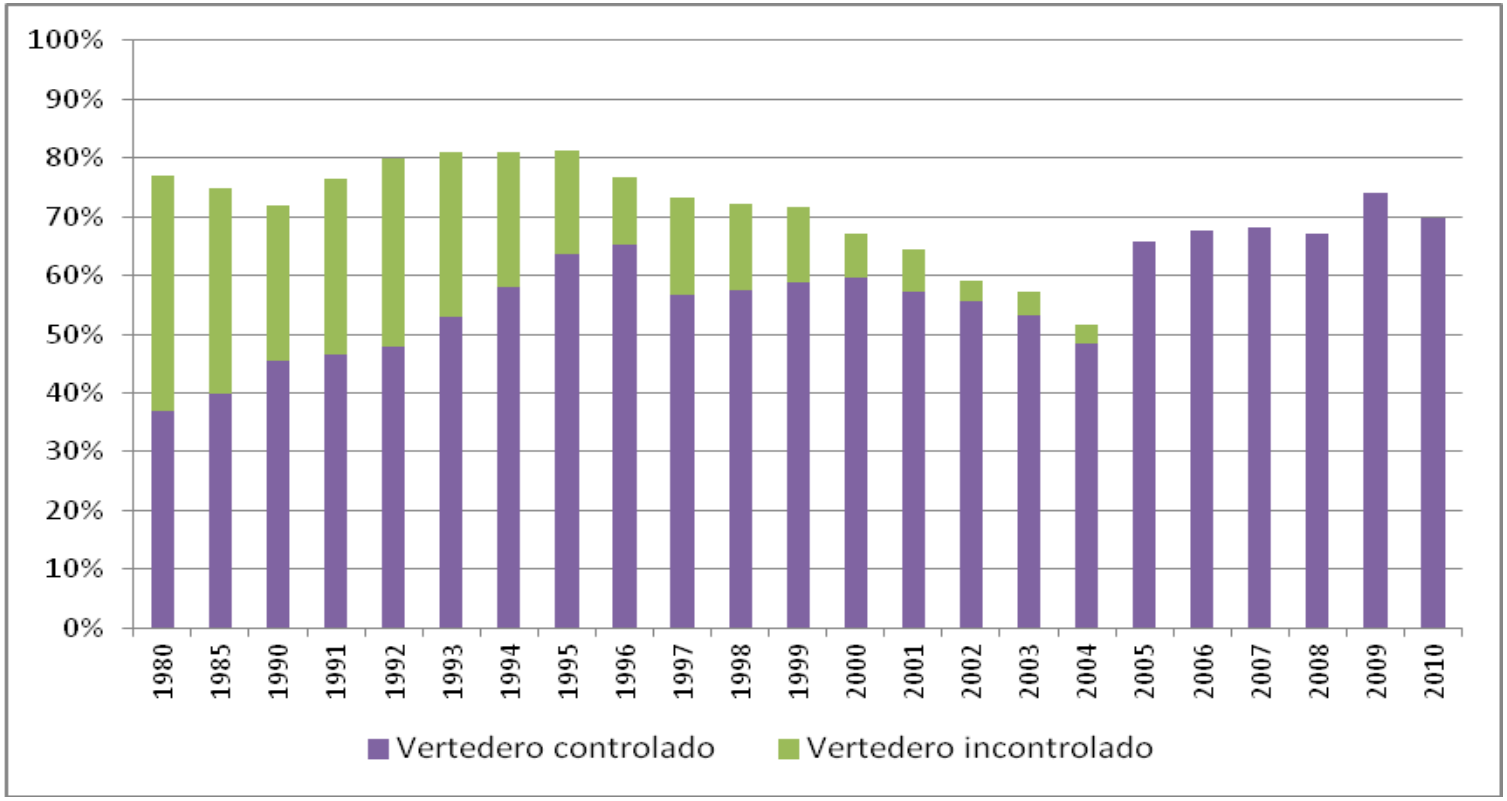
Evolution of municipal solid waste generation in Spain, 1980-2010.



Source: OCDE [19] and MAGRAMA [6 - 18].

LANDFILLING IN SPAIN

Evolution of the percentage of MSW treated in controlled and uncontrolled landfills, 1980-2010.



Source: Own elaboration based on MAGRAMA [6 - 18] and OCDE [19].

NUMBER AND TYPE OF LANDFILLS

Main characteristics of the 134 controlled landfills in Spain, 2009.

Characteristics	2009
Starting year:	
Before 1990	13%
1990 – 2001	60%
2002 – 2005	17%
After 2005	10%
% empty capacity	39%
Average age (years)	11.2
Average capacity (t)	2,300,000
Tonnes per year (average)	123,000
< 5,000 t/year	2%
5,000 – 10,000 t/year	13%
10,000 – 50,000 t/year	27%
50,000 – 100,000 t/year	19%
100,000 – 300,000 t/year	36%
> 300,000 t/year	3%

Source: Uriarte *et al.* [1, 38] and Uriarte [39].

COMPOSITION

Evolution of MSW composition in Spain, 1980-2011

Waste fraction	1980-1989	1990-1994	1995	1996-1998	1999-2006	2007-2011
Biowaste	52.0%	49.0%	44.1%	44.1%	48.9%	44.0%
Paper and cardboard	15.0%	20.0%	21.2%	21.2%	18.5%	21.0%
Plastic	6.0%	7.0%	10.0%	10.6%	11.7%	10.6%
Glass	6.0%	8.0%	6.9%	6.9%	7.6%	7.0%
Ferrous metals	2.5%	4.0%	4.0%	3.4%	2.5%	3.4%
Non-ferrous metals			0.7%	0.7%	1.6%	0.7%
Wood			1.5%	1.0%	0.6%	1.0%
Textile	18.5%	12.0%	4.8%	4.8%	3.7%	0.0%
Rubber			2.0%	1.0%		
Batteries			1.0%	0.2%		
Miscellaneous			3.5%	6.2%	2.9%	12.3%
Cellulosic textiles					2.0%	0.0%

Source: MAGRAMA [6- 17] and OCDE [19].

COMPOSITION

A second methodology consisted of a direct estimation of the composition of waste within the landfills based on the results from the literature.

Composition of material present in landfills, based on 22 studies.

Type of material	Average	Deviation	Number of studies
Soil	54.7%	27%	17
Paper	6.8%	88%	12
Plastic	8.3%	80%	17
Wood	6.8%	64%	14
Textiles / rubber / leather	6.6%	106%	11
Inert materials	10.6%	96%	17
Organic waste	2.7%	73%	4
Ferrous metals	2.9%	106%	14
Non-ferrous metals	0.5%	106%	4
Hazardous waste	0.1%	77%	17
TOTAL	100.0%		

Source: Svensson *et al.* [4].

AMOUNT OF MATERIALS

Estimation of the material present in Spanish landfills, based on waste generated from 1980 to 2010.

Type of material	Amount (t)
Soil	195.649.720
Paper	24.322.086
Plastic	29.687.252
Wood	24.322.086
Textiles / rubber / leather	23.606.730
Inert materials	37.913.840
Organic waste	9.657.299
Ferrous metals	10.372.654
Non-ferrous metals	1.788.389
Hazardous waste	357.678
TOTAL	357.677.734

Source: Own elaboration based on Svensson *et al.* [4] and MAGRAMA ([6 - 18]).

STRATEGIC MATERIALS

Estimation of non-ferrous metals deposited in Spanish landfills, based on waste generated during the period 1980-2010.

Metal no-férrico	Cantidad (t)
Mercurio (Hg)	163
Cadmio (Cd)	298
Plomo (Pb)	39.990
Cromo (Cr)	12.810
Níquel (Ni)	3.592
Cobre (Cu)	10.370
Zinc (Zn)	94.892
Arsénico (As)	183

Source: Own elaboration based on Hogland *et al.* [23] and MAGRAMA ([6 - 18]).

SELECTION CRITERIA

Preliminary criteria to select the most adequate landfills in which to apply landfill mining:

- Take into consideration the remediation of the site.
- Landfills with greater stability facilitate and reduce the risks of the landfill mining activity.
- Big landfills to be prioritised.
- Take into consideration the age of the landfill: more modern landfills have higher presence of valuable materials and less degraded materials.
- Distance to inhabited places to prevent nuisances related to noise, dust, bad smells, etc.
- Not sealed landfills are cheaper to exploit.

Future prospects.

CO2eq EMISSIONS

A balance of CO2eq emissions needs to compare generated with avoided emissions.

According to Krook [46], CO2eq emissions generated during the process of landfill mining (stationary plants) come from incineration of materials (62.3%), waste and materials transportation (33.3%), activities in the landfill (3.5%) and separation of materials (0.5%).

Avoided CO2eq emissions are due to energy recovery (43.3%), recycling of recovered materials –plastic, ferrous and non-ferrous metals, etc.– (41.9%), and 14.9% from avoidance of methane emissions.

These percentages depend quite a lot depending on types of landfill mining processes and types of treatments applied to recovered materials; however, in general, emissions generated during extraction, separation and treatment are generally lower than avoided emissions.

OTHER ASPECTS

Other aspects that were analysed in the report are:

- A review of the different technologies that can be used for landfill mining.
- A preliminary estimation of cost for excavation and processing the materials.
- The amount of the imports for several strategic material resources in Spain and a comparison to the amount of them present in landfills.
- An estimation of the market value of the resources that could be captured.
- An overall very preliminary economic balance.
- An estimation of the amount of direct and indirect jobs that could be created by landfill mining.

CONCLUSIONS

- The presence of valuable materials within wastes being landfilled in the past offers a potential opportunity to save imports and reduce exports of selected relevant materials, some of which are economically strategic.
- The logic priority should be to prioritise the easiest options to capture these materials, which is not landfill mining but separate collection, particularly of WEEE.
- Capturing resources by means of landfill mining requires a complex system that may adopt different technological and organisational solutions, which should be studied in detail and for each concrete landfill, defining carefully the responsibilities of the different involved agents.
- Landfill mining will gain importance in the future, as technologies get better and as the price of raw materials continues to rise.

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Thanks for your attention