

Country report presentation at the WG 2 meeting in Tallinn, Estonia 9-11 August

Finland 

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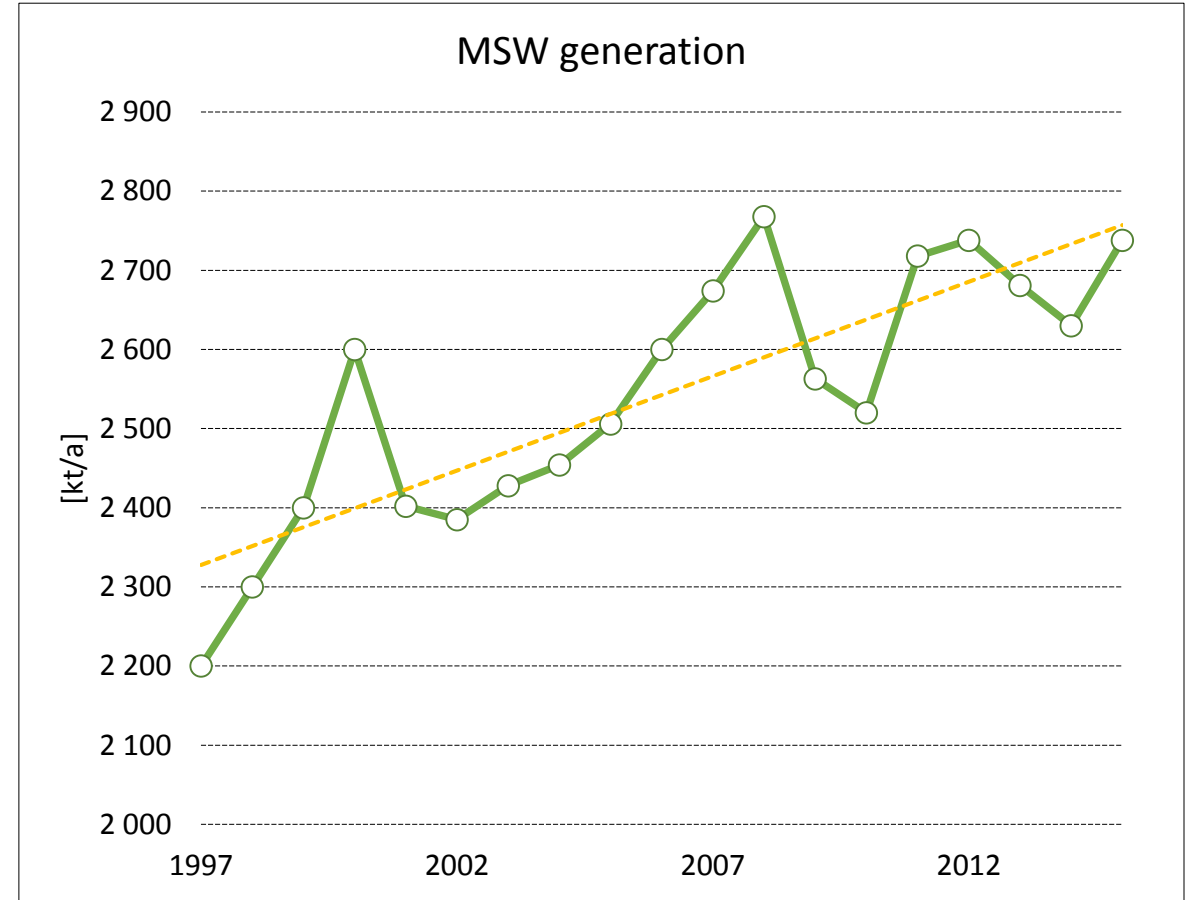
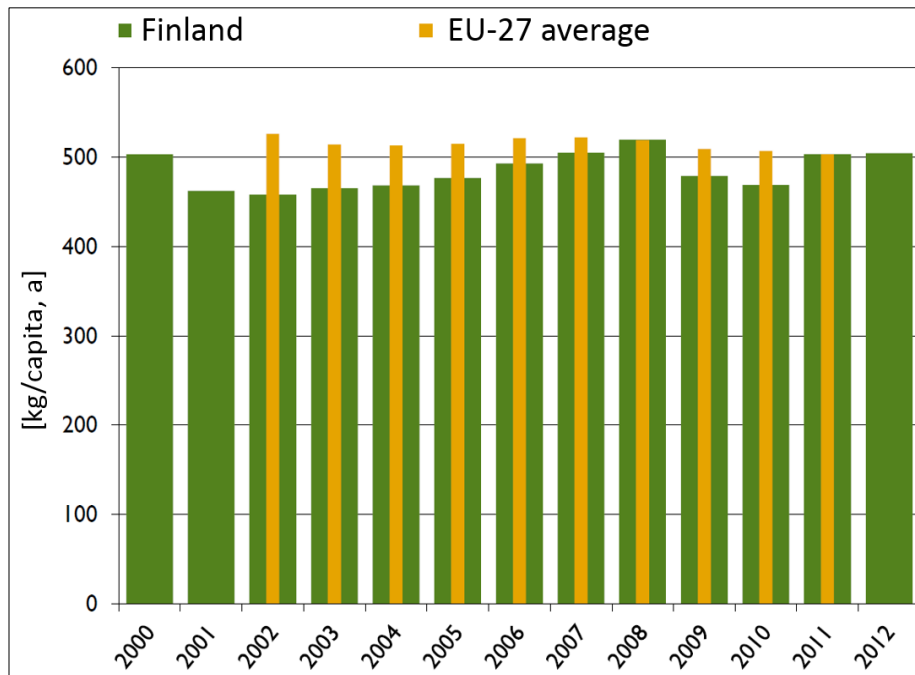
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MSW generation and treatment in Finland

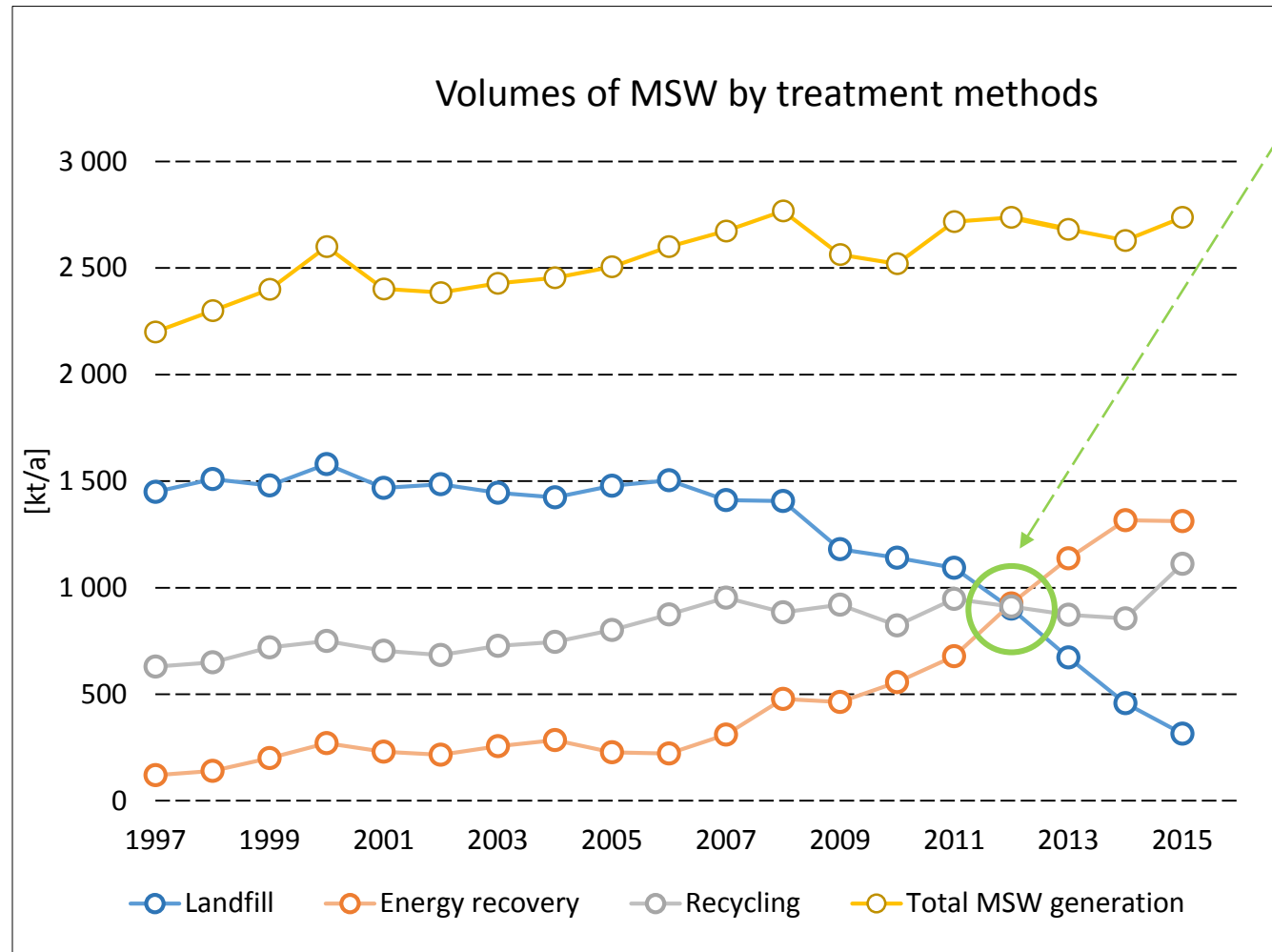
- MSW statistics available from 1997 onwards
- MSW generation has steadily increased since 1997
- MSW generation rate per capita has remained at the same level in the 2000s (~500 kg/ capita, a)



Statistics Finland, 2017



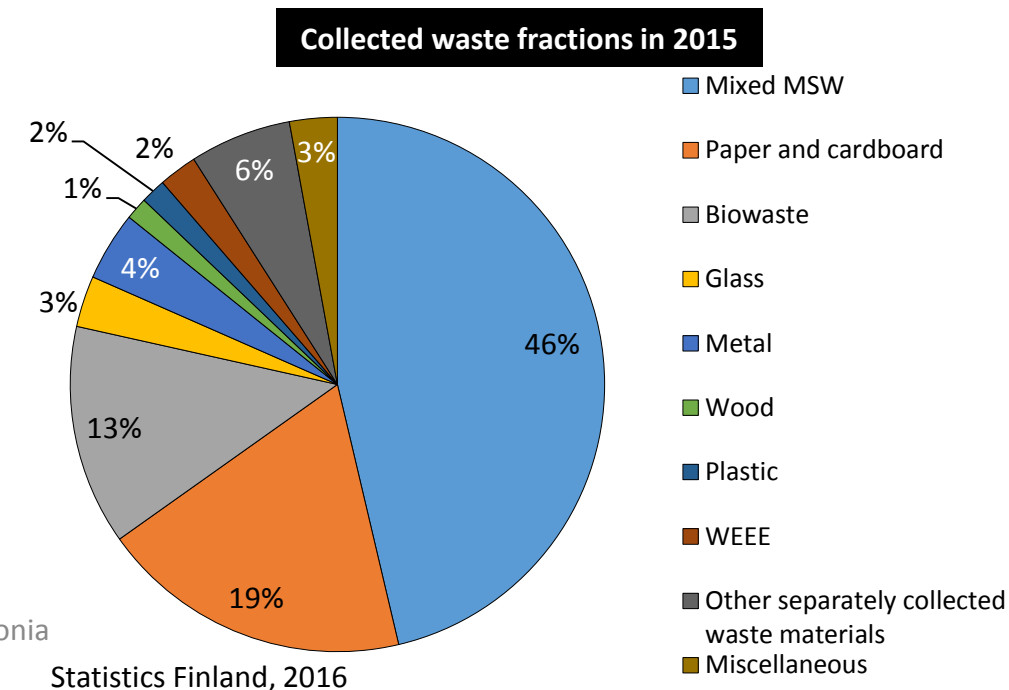
MSW generation and treatment in Finland



Statistics Finland, 2017

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- Year 2012 was a turning point
- In **2015**:
 - The recycling rate was 40.6%
 - 11.5% of MSW was disposed of in landfills
 - 47,9% of MSW was incinerated (with energy recovery)



Statistics Finland, 2016



Waste policy and regulatory frameworks

- Main policies and regulations regarding waste management:
 - Waste Directive (2008/98/EC)
 - Environmental Protection Act (527/2014) and Degree (713/2014)
 - Waste Act (646/2011) and Degree (179/2012)
 - Landfill Degree (331/2013)
 - Regional/municipal MSW management regulations
- EU waste and landfill regulations are fully implemented in Finland
 - Room for improvement in the recycling of MSW
 - Significant actions are needed to reach the 50% recycling target of the EU by 2020, let alone the 65% recycling target by 2030
- Most important national regulations/target in the last decade:
 - Landfill ban on organic waste from 2016 onwards
 - Landfill tax is currently 70 €/t (has increased significantly during the last decade)
 - Full producer responsibility for packaging waste from 2015 onwards
 - 50% MSW recycling rate by the end of 2016 → was not achieved



Waste policy and regulatory frameworks

- Acceptance criteria for waste (landfills) – chemical properties (concentration/solubility, depending on a substance in matter)
 - Different criteria for non-hazardous waste, hazardous waste and inert waste landfills
 - Determined in Landfill Degree (331/2013)
- Gate fees:
 - Landfills: landfills tax (70 €/t) + material specific treatment payment (can vary significantly regionally)
 - Incineration: ~45 €/t (a rough estimate) (Pöyry, 2015)
 - Composting or anaerobic digestion plants (biowaste): ~60-100 €/t (Setälä et al., 2011)

Subst./parameter	Inert waste LF	Non-hazardous waste LF	Hazardous waste LF
As (mg/kg)	0.5	2.0	25.0
Ba (mg/kg)	20.0	100.0	300.0
Cd (mg/kg)	0.04	1.0	5.0
Cr (mg/kg)	0.5	10.0	70.0
Cu (mg/kg)	2.0	50.0	100.0
Hg (mg/kg)	0.01	0.2	2.0
Mo (mg/kg)	0.5	10.0	30.0
Ni (mg/kg)	0.4	10.0	40.0
Pb (mg/kg)	0.5	10.0	50.0
Sb (mg/kg)	0.06	0.7	5.0
Se (mg/kg)	0.1	0.5	7.0
Zn (mg/kg)	4.0	50.0	200.0
Cl ⁻ (mg/kg)	800.0	15 000	25 000
F ⁻ (mg/kg)	10.0	150.0	500.0
SO ₄ ²⁻ (mg/kg)	1 000	20 000	50 000
Phenol index (mg/kg)	1.0		
DOC (mg/kg)	500.0	800.0	1 000
TDS (mg/kg)	4 000.0	60 000	100 000
TOC (%)	3.0	5.0	60 000.0
BTEX mg/kg	6.0		
PCB (mg/kg)	1.0		
Mineral oil (C10-C40) (mg/kg)	500.0		
PAH (mg/kg)	40.0		
Ph		> 6.0	
LOI (%)			10.0



Overview of available data on landfills

- Available information about Finnish landfills
 - Statistics Finland – information about the amount of MSW disposed of in landfills (1997 →)
 - A database of Finnish Environment Institute – *“Listing of operating, non-operating and planned waste disposal sites (landfills) in 2016”*
 - Not publicly available
 - All types of registered landfills (both industrial and municipal landfills) in Finland are listed
 - The following information about landfills is provided in the database: location, name, type (inert, non-hazardous, hazardous, industrial, etc.), state (operating, non-operating, planned) and the operator of a landfill
- Information about contaminated soils (including landfills) in Finland
 - MATTI DATA PORTAL of the Finnish Environment Institute
 - Information has been collected since the beginning of 1990s

Landfill situation – specific data on MSW landfills



A database of Finnish Environment Institute – *“Listing of operating, non-operating and planned waste disposal sites (landfills) in 2016”*

- There are in total 2 536 registered landfills in Finland of which,
 - 2 170 are not operating (closed)
 - 16 are planned/operation has not yet been started
 - 350 are currently operating
- No information about the disposed waste volumes in these landfills is available in the database
- Operating landfills (350):
 - Soil landfills: 164
 - Inert waste landfills: 36
 - **Non-hazardous waste landfills: 115**
 - Industrial: 66
 - [Municipal/regional \(i.e. public\): 49](#)
 - Hazardous waste landfills: 35



Landfill technology and practice

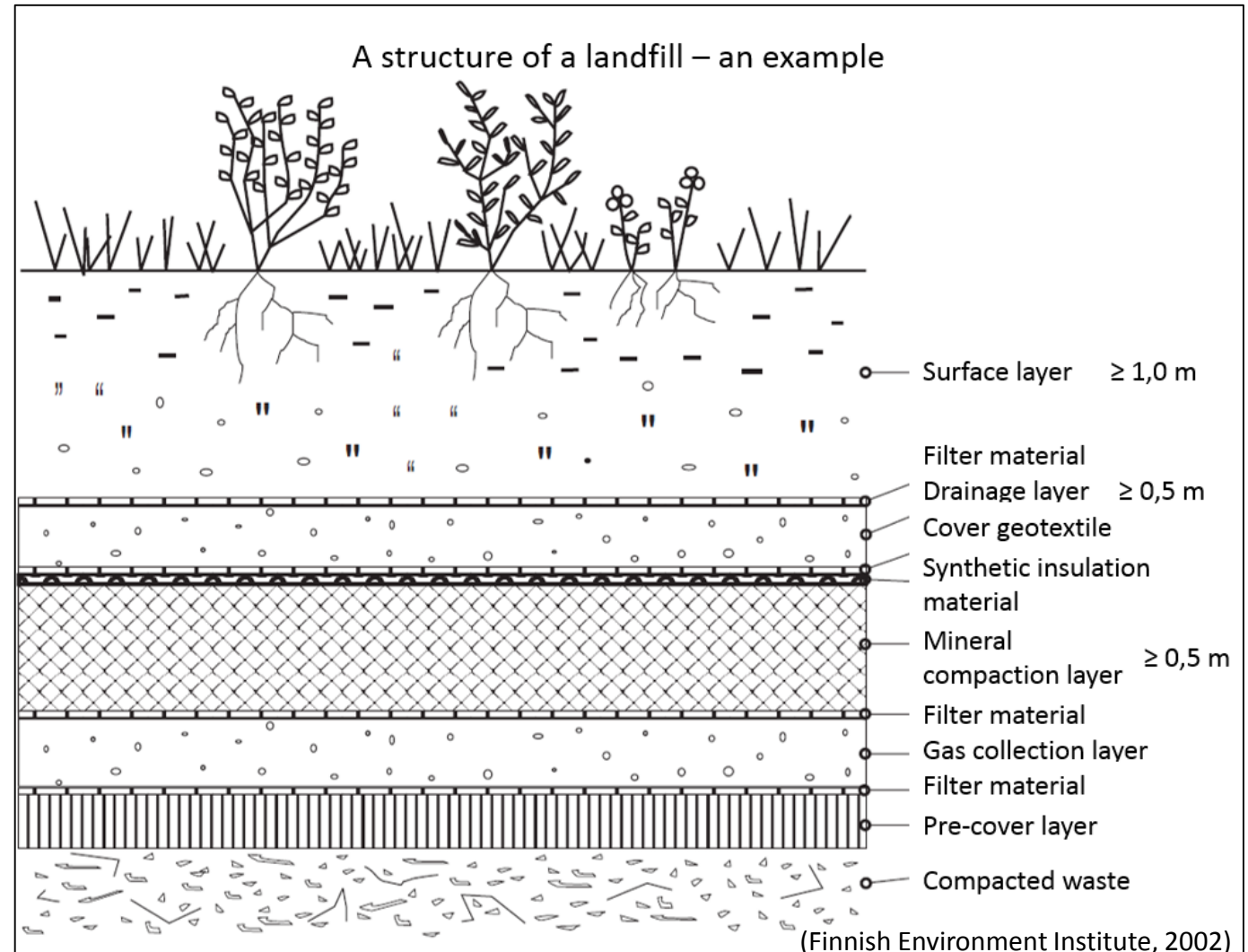
- Current practices for the operation of MSW landfills:
 - Protection layers:
 - Surface layer ≥ 1 m is required both in non-hazardous and hazardous waste landfills
 - Bottom/base structure:
 - Non-hazardous waste landfills: $K \leq 1,0 \cdot 10^{-9}$ m/s, thickness ≥ 1 m
 - Hazardous waste landfills: $K \leq 1,0 \cdot 10^{-9}$ m/s, thickness ≥ 5 m
 - Inert waste landfills: $K \leq 1,0 \cdot 10^{-7}$ m/s, thickness ≥ 1 m
 - Surface structure:
 - Surface layer ≥ 1 m is required both in non-hazardous and hazardous waste landfills
 - Drainage layer $\geq 0,5$ m is required both in non-hazardous and hazardous waste landfills
 - Compaction layer $\geq 0,5$ m is required both in non-hazardous and hazardous waste landfills
 - A layer made of synthetic encapsulation material is required in hazardous waste landfills
 - LFG collection system is required in non-hazardous waste landfills; in hazardous-waste landfills, it is required at need
 - Leachate collection system is required in non-hazardous and hazardous waste landfills
 - LFG collection and treatment
 - Most common practices combustion with energy recovery and flaring
 - In 2014, 80 % of generated LFG was utilized (combusted with energy recovery); the rest 20 % was flared (Huttunen and Kuittinen, 2015)
 - The generated energy is mainly utilized as heat

Landfill Degree
(331/2013)



Landfill technology and practice

- Closure and aftercare treatment of landfills
 - Most common practice in Finland: covering as well as monitoring and treatment of emissions (LFG and leachate)
 - Aftercare treatment is obligated to continue for 30 years after closure
- Landfill reclamation is not common yet in Finland



Experiences from landfill mining projects in Finland



- A few landfill mining projects have been implemented in Finland during the last decade
 - MSW landfills (non-hazardous waste landfills)
- *Kaivanto – Landfill mining –project*
 - Responsible organization: VTT (Technical Research Centre of Finland)
 - Several research partners
 - The objective of the project was to evaluate the material and energy recovery potential of landfill mining. Additionally, an objective of the project was to examine whether Finnish companies can find business opportunities in landfill mining.
 - Landfill:
 - Located in the city of Kuopio
 - A land area of ~32 000 m² and a peak area of ~18 000 m²
 - The maximum filling height is ~30 m
 - The content of the landfill: mixed MSW during the years 2001-2011
 - Sampling procedure is described in Kaartinen et al. (2013) in detail
 - Publication:
 - Kaartinen, T., Sormunen, K., Rintala, J., 2013. Case study on sampling, processing and characterization of landfilled municipal solid waste in the view of landfill mining. *Journal of Cleaner Production* 55 (15), 56-66.

Experiences from landfill mining projects in Finland



- Other landfill mining studies in Finland
 - Sormunen, K., Ettala, M., Rintala, J., 2008. Detailed internal characterisation of two Finnish landfills by waste sampling. *Waste Management* 28 (1), 262-163.
 - The aim of the study was to determine the structure and composition of landfilled waste at two Finnish landfills
 - Landfills:
 - Ämmässuo, Espoo
 - 17 years in operation (established in 1987)
 - The largest landfill in Scandinavia (the total amount of landfilled waste is ~8 million tonnes)
 - Kujala, Lahti
 - 48 years in operation (established in 1955)
 - The total amount of landfilled waste was ~2,3 million tonnes in 2003
 - Conclusions: waste sampling is a feasible manner to characterize the landfill body despite high variation between samples
 - Results of the study cannot be generalized due to different waste management methods and landfilling histories → results apply only to these particular landfills

Experiences from landfill mining projects in Finland



- Other landfill mining studies in Finland
 - Mönkäre, T. J., Palmroth, M. R. T., Rintala, J. A., 2016. Characterization of fine fraction mined from two Finnish landfills. *Waste management* 47 (part A), 34-39.
 - Fine fraction was mined from two MSW landfills in Kuopio and Lohja – the objective of the study was to determine the composition of the mined fine fraction
 - Landfills:
 - Kuopio (1- to 10-year old → new landfill)
 - Contains MSW landfilled between 2001 and 2011
 - Lohja (24- to 40-year-old → old landfill)
 - Contains MSW, construction waste and soil landfilled between 1967 and 1989
 - Results:
 - Fine fraction (< 20 mm) was 45-58 % of the content of the landfills
 - Organic matter content of fine fraction was low compared to "fresh" MSW



References

- Finnish Environment Insitutute, 2002. Kaatopaikan tiivistysrakenteet (in Finnish) (Landfill Sealing Structures). Environment Guide 36. <https://helda.helsinki.fi/bitstream/handle/10138/41085/Ymp%C3%A4rist%C3%B6pas_36.pdf?sequence=1> (accessed 27.6.2017).
- Huttunen, M. J. and Kuittinen V., 2015. Suomen biokaasurekisteri n:o 18 (in Finnish). <http://epublications.uef.fi/pub/urn_isbn_978-952-61-1875-8/urn_isbn_978-952-61-1875-8.pdf> (accessed 27.6.2017).
- Kaartinen, T., Sormunen, K., Rintala, J., 2013. Case study on sampling, processing and characterization of landfilled municipal solid waste in the view of landfill mining. Journal of Cleaner Production 55 (15), 56-66.
- Mönkäre, T. J., Palmroth, M. R. T., Rintala, J. A., 2016. Characterization of fine fraction mined from two Finnish landfills. Waste management 47 (part A), 34-39.
- Pöyry, 2015. Jätteen energiahödyntäminen Suomessa (Waste incineration in Finland) (in Finnish). <https://energia.fi/files/405/ET_Jatteiden_energiakaytto_Loppuraportti_161015.pdf> (accessed 27.6.2017).
- Salmenperä, H., Moliis, K., Nevala, S-M., 2015. Jättemäärien ennakointi vuoteen 2030 (Forecasting waste volumes to 2030 – focusing on municipal waste and reching recycling targets) (in Finnish). Reports of the Ministry of the Environment 17/2015.
- Setälä, J., Tarkki, V., Mannerla, M., Vielma, J., 2011. Vajaasti hyödynnetyn kalan kaupalliset käyttömahdollisuudet (in Finnish). <https://jukuri.luke.fi/bitstream/handle/10024/530750/rktltr2011_11.pdf?sequence=1&isAllowed=y>
- Sormunen, K., Ettala, M., Rintala, J., 2008. Detailed internal characterisation of two Finnish landfills by waste sampling. Waste Management 28 (1), 262-163.
- Statistics Finland, 2016. Jätetilaste 2015 (Waste statistics 2015) (in Finnish). <http://www.stat.fi/til/jate/2015/jate_2015_2016-12-20_fi.pdf> (accessed 27.6.2017)
- Statistics Finland, 2017. Municipal waste by treatment method in 1997 to 2015. <http://pxnet2.stat.fi/PXWeb/pxweb/en/StatFin/StatFin__ymp__jate/010_jate_tau_101.px/?rxid=2b3b5312-f4b9-4e99-bdc8-efaacaa15d18> (accessed 22.6.2017)>.