

ELFM CASE STUDY

This lesson plan will introduce students to the Remo landfill site and explore valorisation options.

LESSON OBJECTIVES

Students will be able to:

- Compare classic and enhanced landfill mining
 - Suggest waste valorisation options used in current ELFM case studies
 - Use research papers to find information
 - Understand the plasma gasification process
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SUMMARY OF TASKS

PART 1 – ENHANCED LANDFILL MINING

- Ask students to discuss the difference between classic and enhanced landfill mining in pairs, then share their ideas with another pair. Decide on one definition for each word and write it on the board. Discuss their answers with the whole group (more information and key definitions in 'Introduction to Enhanced Landfill Mining' lesson plan).

PART 2 – REMO CASE STUDY

- Introduce the REMO case study
- Discuss the difference between the composition of excavated landfill waste and fresh waste using the 'Remo Case Study' activity sheet, consider degradation of waste, changes in waste management and new legislation
- Complete the 'Remo Case Study' activity sheet using the 'Valorisation of materials within Enhanced Landfill Mining: what is feasible?' research paper¹ and additional resources listed

PART 3 – PLASMA GASIFICATION

- Watch 'NEW-MINE – EU Training Network for Resource Recovery Through Enhanced Landfill Mining' video² (3 mins) to introduce plasma gasification
 - Finish the 'Remo Case Study' activity sheet
 - Watch 'NRG Energy Plasma Gasification MSW' video³ (7 mins).
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RESOURCES/ EQUIPMENT

- 'Enhanced Landfill Mining Case Studies' fact sheet
- 'Remo Case Study' activity sheet
- Access to a computer

HOMEWORK/ EXTRA ACTIVITIES

- Identify further examples of ELFM case study e.g. Scotland Reclamation site
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¹ https://eurelco.org/wp-content/uploads/2018/10/f593b3_66a929ab37b94ea9b5fdc7a71ffdc4da.pdf

² <https://www.youtube.com/watch?v=8pkGfARjPao>

³ <https://www.youtube.com/watch?v=CBqx8t-YLrw>

FACT SHEET: ELFM CASE STUDY

FACT SHEETS HAVE BEEN DESIGNED FOR TEACHER USE TO AID CREATING OF TEACHING RESOURCES, OR THEY ARE FREE TO BE REPURPOSED FOR STUDENT USE.

PART 1 – ENHANCED LANDFILL MINING

	Classic landfill mining	Enhanced landfill mining
Aim	(1) Reclaim the land for redevelopment (2) Improve environmental issues	Maximise valorisation options for materials, energy and land
Time frame	Fast solution (few months – 2 years)	Long-term solution (10-25 years)
Resource recovery?	No focus on resource recovery	Primary focus is on resource recovery

PART 2 – REMO CASE STUDY

The main objective of ELFM is to achieve valorisation of excavated waste from the landfill. The main challenge of this is the heterogenous nature of the waste streams so it is difficult to develop a suitable treatment and separation stages which enables maximum material valorisation.⁴

- Remo landfill site is located in Belgium and has been operational since the 1970s.
- There is a large area of non-hazardous waste which is being considered for ELFM.
- Roughly half of the 16.5 million tonnes of landfill waste is household waste, with the other half being industrial waste, metallurgical slags or dried sludge.
- There is also leachate present, which arises from water passing through the landfill.
- Lots of work has been done on determining the composition of the waste.
- Around 45% of the waste could be recycled as WtM.
- A large proportion of the waste could be used for energy generation.

PART 3 – PLASMA GASIFICATION

There has been investigation into the use of plasma gasification as a technology for thermal valorisation, which the Remo site plans to implement. The waste can be pre-treated to remove any valuable metals or recyclable materials and the remaining waste is heated to high temperatures and

⁴ Quaghebeur et al., 2010, *Valorisation of materials within Enhanced Landfill Mining: what is feasible?*
https://eurelco.org/wp-content/uploads/2018/10/f593b3_66a929ab37b94ea9b5fdc7a71ffdc4da.pdf

Enhanced Landfill Mining
Age range: 14-18 years

turns it into a renewable gas. The residues left over from this process can be converted into 'plasmarok' which can be used as bricks.

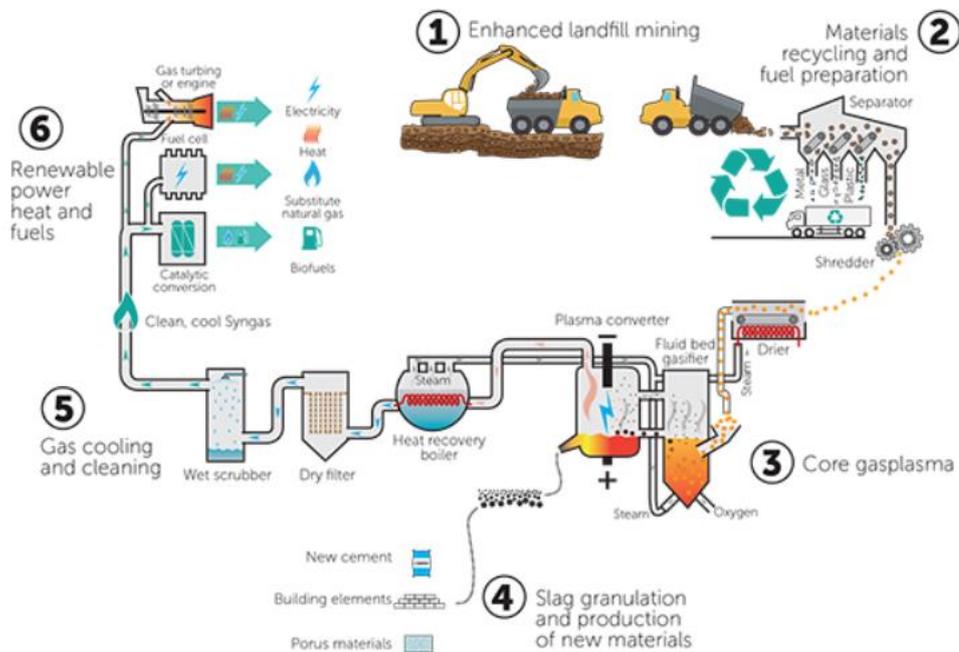


Figure 1: Plasma gasification (Figure taken from <https://machiels.com/en/division/europe/environmental-services/landfill-mining-solutions/>, infographic by Paul Wootton.⁵

ADDITIONAL RESOURCES:

- https://eurelco.org/wp-content/uploads/2018/10/f593b3_66a929ab37b94ea9b5fdc7a71ffdc4da.pdf - accessible research paper about Remo landfill site
- https://www.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1563450552.pdf - accessible presentation that could be adapted
- [https://waste-management-world.com/a/closing-the-circle-enhanced-landfill-mining#:~:text=The%20REMO%20landfill%20site%20in%20Houthalen%2DHelchteren%20\(Belgium\)%20currently,of%20household%20and%20industrial%20waste.](https://waste-management-world.com/a/closing-the-circle-enhanced-landfill-mining#:~:text=The%20REMO%20landfill%20site%20in%20Houthalen%2DHelchteren%20(Belgium)%20currently,of%20household%20and%20industrial%20waste.)
- <https://www.ft.com/content/0bf645dc-d8f1-11e7-9504-59efdb70e12f>
- <https://machiels.com/en/division/europe/environmental-services/landfill-mining-solutions/>
- <https://www.imeche.org/news/news-article/feature-taking-out-the-trash-how-engineers-could-tackle-the-landfill-problem>
- http://www.wrap.org.uk/sites/files/wrap/Feasibility%20and%20Viability%20of%20LFMR%20Scotland%20190413_0.pdf

⁵ <https://machiels.com/en/division/europe/environmental-services/landfill-mining-solutions/>

ACTIVITY: REMO CASE STUDY

Instructions

Please see the web page for more information about Enhanced Landfill Mining.

This activity is intended to prompt thinking and discussion about the Remo case study and potential waste valorisation opportunities.

This activity is intended to be used alongside the 'Enhanced Landfill Mining case studies' lesson plan and 'Valorisation of materials within Enhanced Landfill Mining: what is feasible?' research paper.

Task

If you are based in a classroom

Students should already understand the terms ELFM, MSW, WtE and WtM

This is a research-based activity to familiarise students with research papers.

Students should be given a copy of the research paper, with key areas highlighted, to help answer the questions below but should be encouraged to attempt the questions beforehand.

This should prompt group discussion on the possible advantages and disadvantages of various valorisation approaches.

If you are doing this activity at home

The student could do this as a stand-alone activity and answer the questions from this activity using the information provided in the research paper.

The student could go on to research plasma gasification in more detail.

1. COMPOSITION OF LANDFILLED WASTE

a. Explain the difference in composition between landfilled waste and fresh waste (*Page 6 and 7*).

Table 1: Average compositions of landfilled waste (1995-2000) excavated from the Remo landfill site compared to fresh MSW sampled in Flanders (2000) - Table reproduced from published report⁶

Waste Fraction	Landfilled waste (1995-2000)	Fresh waste (2000-2001)
Glass	0.5	2.4
Metal	2.2	3.2
Textile	3.1	2.9
Wood	4.1	-
Paper/cardboard	14	14
Plastic	25	24
Organic	-	43
Inert fraction	2.0	3.3
Fine fraction (<10 mm)	45	-
Other	4.1	6.6

b. How could landfill waste be expected to differ based on how old it is? (*Page 5 has some information*)

Consider the degradation of waste, changes in waste management and new legislations.

⁶ https://eurelco.org/wp-content/uploads/2018/10/f593b3_66a929ab37b94ea9b5fdc7a71ffdc4da.pdf

2. VALORISATION OPPORTUNITIES

Outline the treatment required and valorisation options for each fraction below (*Use page 12 and 13 to help with this, but could also look up additional options on Google*).

Waste Fraction	Treatment required	Valorisation option
Fine soil		
Metals, glass/ceramics and stone		
Paper, textile, wood and plastic		
Leachate		

3. PLASMA GASIFICATION

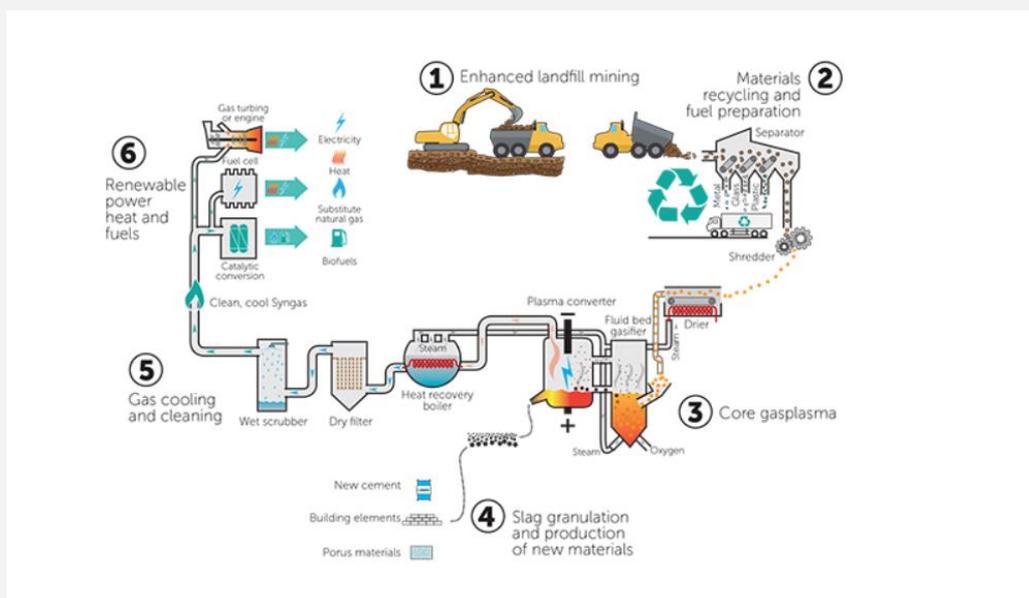


Figure 1: Plasma gasification (Figure taken from <https://machiels.com/en/division/europe/environmental-services/landfill-mining-solutions/>, infographic by Paul Wootton.⁷

Research plasma gasification using the resources given and any other resources you can find.

Consider the following:

- How does plasma gasification work?
- What pre-treatments are required before the waste can be used?
- What products are produced and how can these be used?
- How green is this method?
- Are there any problems with this technology?

⁷ <https://machiels.com/en/division/europe/environmental-services/landfill-mining-solutions/>