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**LFM, ELFM and Interim Use as part of
an integrated Dynamic Landfill
Management strategy**

July 2019



Group Machiels' Remo landfill

Location

Houthalen-Helchteren, east of Belgium

Activities of Remo as of today

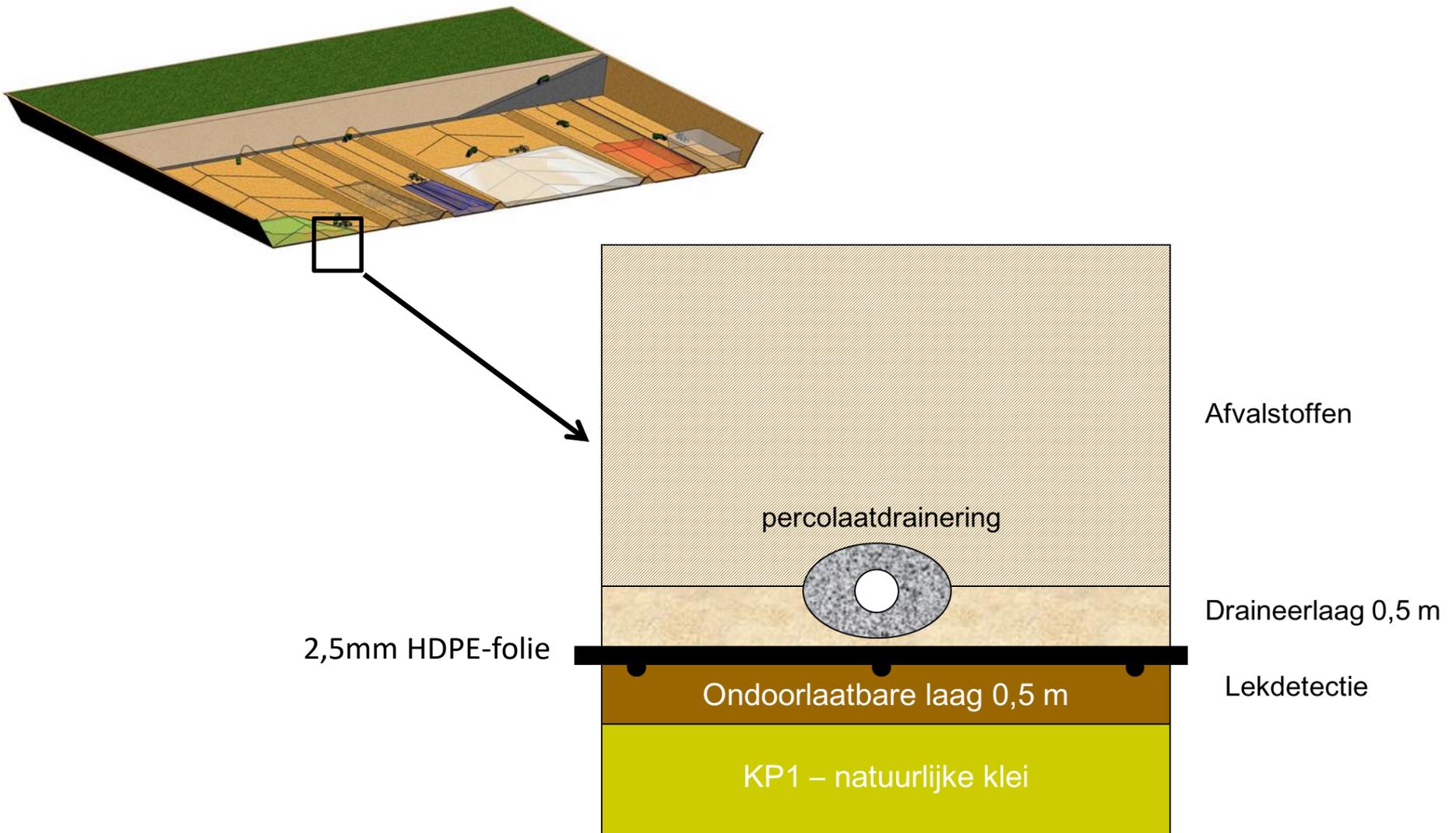
State-of-the-art landfill for industrial waste from recycling processes (\pm 300 kton/annum)

Transition towards Closing the Circle

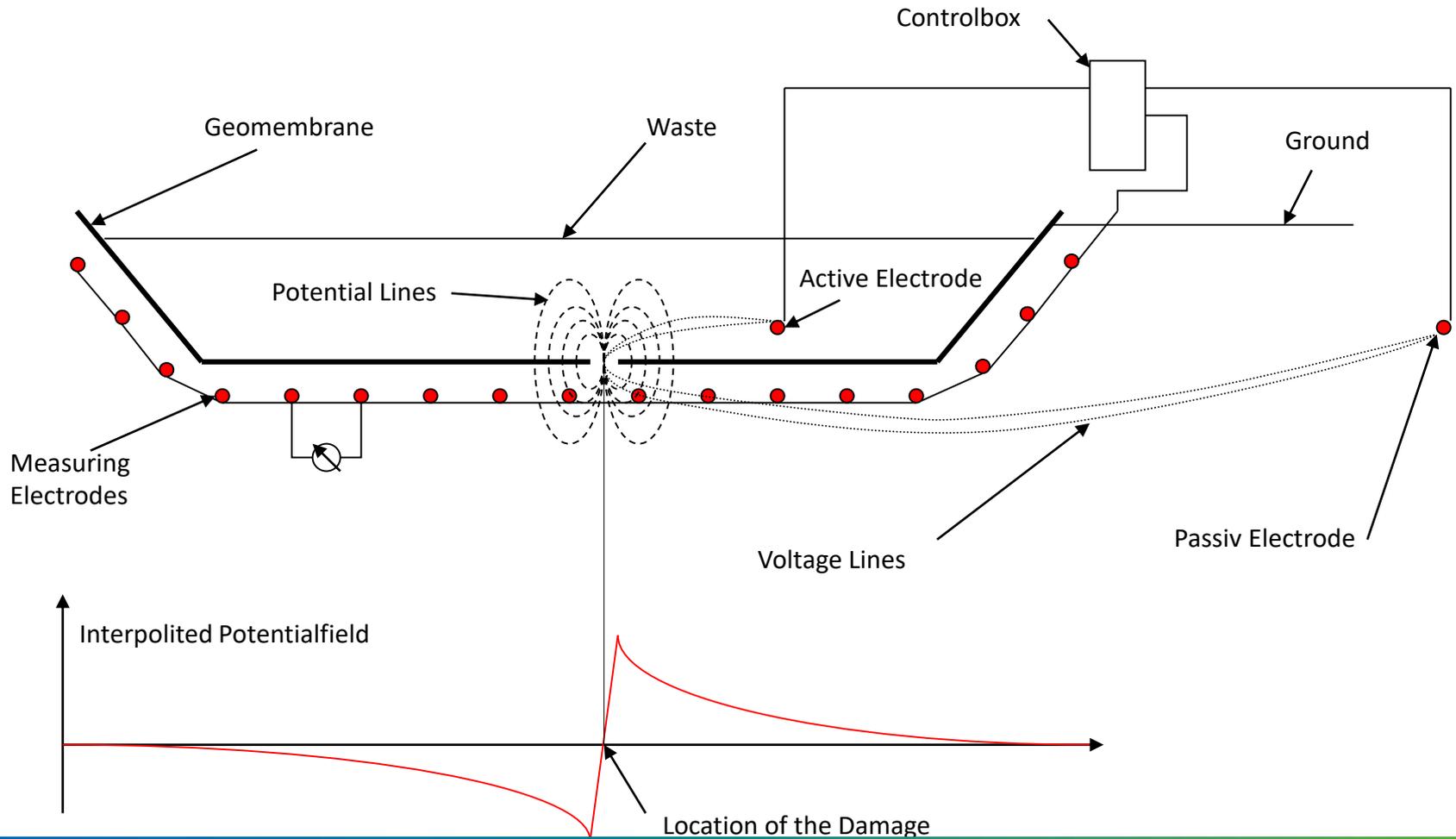
Landfill represents a reserve of materials and energy. The reclaimed land can be redeveloped to create an integrated nature park after mining of the landfill.



Landfill design



Leak detection system



Implementation of landfill



On site water treatment plant & CHP landfill gas valorisation

Purification of leachate, extraction and valorization (CHP) of methane gas

Reversed Osmosis (RO)

- Today, Group Machiels is able to offer worldwide, together with her industrial partners, based on a wide range of international experience, **sustainable, reliable and integrated waste management solutions** including:
 - The design, implementation and operation of state-of-the-art landfills including water treatment and landfill gas valorisation
 - Classic landfill mining
 - Enhanced landfill Mining, the concept behind our Closing the Circle project
 - Consultancy services including setting up a roadmap to migrate a city or region to a higher waste management maturity level as well as guiding our customers in the implementation of this roadmap

International waste management best practises



Location

Santiago de Chile

Activity

Receiving, processing, recycling and storing industrial waste flows.



Location

Region VIII, Concepción

Activity

Receiving and storing household and industrial waste flows coming from Region VIII.



Location

El Teniente – Codelco –
Andes mountains Rancagua.

Activity

Receiving of slags from melting ovens in the copper mine. Treating it and storing it for future re-use in the copper production process.



Location

Salt desert “salar de Atacama” in northern Chile.

Activity

Receiving waste flow containing arsenic from the copper mines in northern Chile. Neutralizing, stabilizing and storing of waste materials.

Classic Landfill Mining vs Enhanced Landfill Mining

- Most appropriate landfill mining solution for USW landfills to be tailored based on project driver(s) and objectives

- Option A: **“Classic” Landfill Mining (LFM)**
 - Drive: Resolve environmental problem and/or reclaim land for redevelopment
 - Duration: Few months to 2 years (**FAST** solution)
 - Equipment: Mainly mobile installations
 - Ambition level of resource recuperation: secondary focus

- Option B: **“Enhanced” Landfill Mining (ELFM)**
 - Drive: Maximize potential of materials, energy and land recuperation
 - Duration: 10 to 25 years (**TAILORED** solution)
 - Equipment: Mainly stationary installations
 - Ambition level of resource recuperation: primary focus

Standard methodology to tailor best possible solution



- Phase 1:
 - Model possible technical solutions in standard economical model based on initial problem description, available case information and populated LFM questionnaire
- Phase 2:
 - Collect and address questions, remarks and concerns of client
 - Determine, given a preliminary approval, the required actions for the retained scenarios to refine and confirm key assumptions from first modelling exercises:
 - Perform waste drillings to confirm the landfill conditions and composition
 - Assess desired project lead time and scope, battery limits and economical assumptions
 - Develop quotation for implementation of defined actions
- Phase 3:
 - Carry out tasks and activities after formal approval in order to develop detailed quotation of proposed project solution
 - Present final report on proposed solution

Classic Landfill Mining



The Closing the Circle masterplan



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CLOSING THE CIRCLE • ENHANCED LAND FILL MINING

C. DUURZAAM NATUURGEBIED

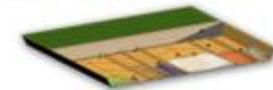
B. CLOSING THE CIRCLE

A. ACTUELE SITUATIE

1 FASE I:
Tijdelijke opslag

2 ZONE VOOR INSTALLATIES:
FASE II plasma demonstratie installatie
en FASE III full scale closing the circle
(uitbreiding u1 en u2)

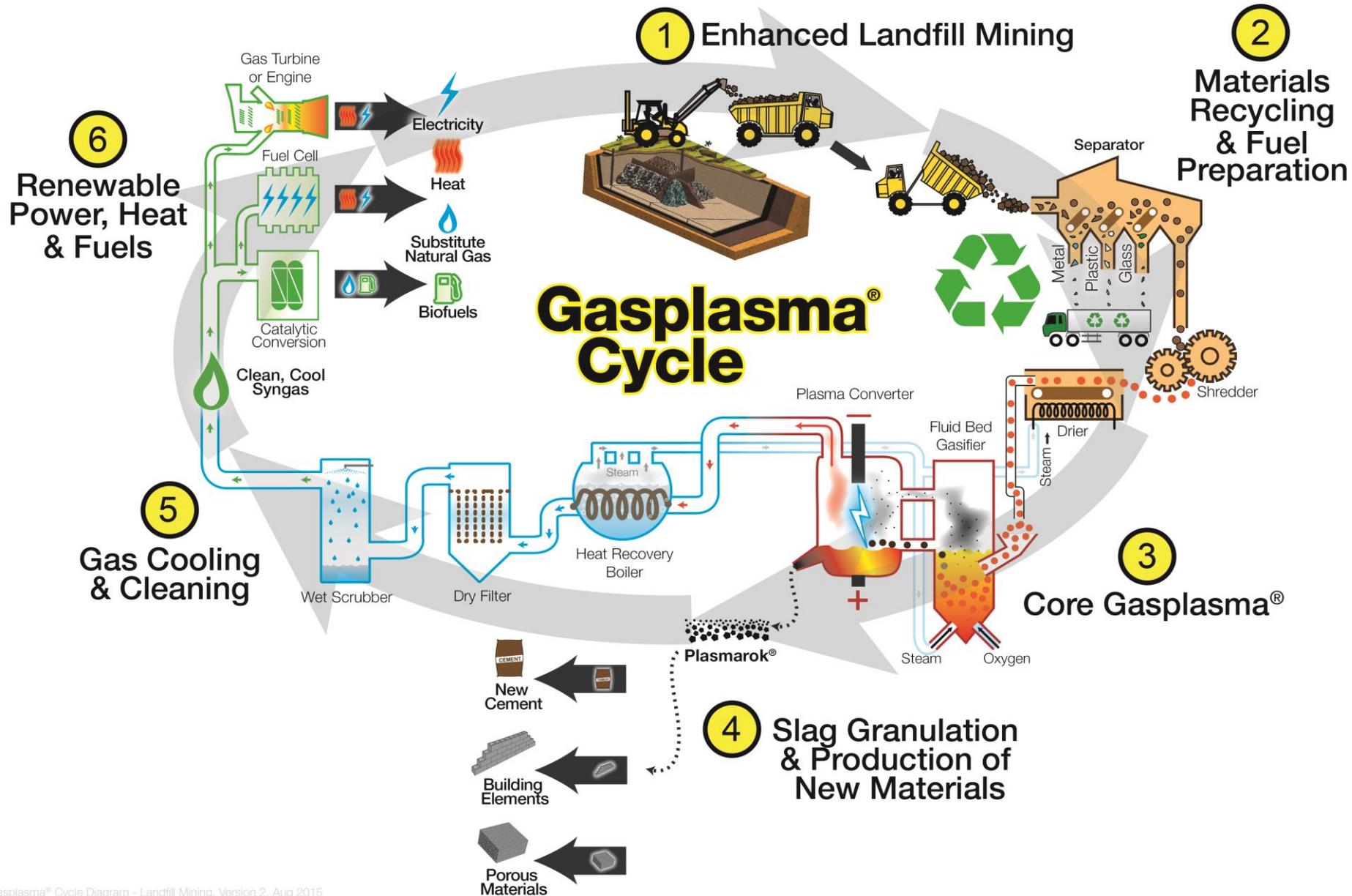
3 FASE III:
Zone voor finale opslag



Key Figures

- Total area: 230 ha
- 143 ha landfill
- 16+ Mtons waste stored

Upcycling technologies as a leverage to create a sustainable economical model



Scope of demonstration plant

2. Storage sorted waste streams and RDF preparation plasma plant

4. Syngas upcycling to hydrogen

6. Hydrogen distribution and fuelling stations

3. Plasma plant

5. Pressurize and store hydrogen

1. Sorting of mined waste

Line (m)	Size (m)	Hoogte dakrand (m)
766	8190	17.0
1980	17885	17.0
221	7821	17.0
8641	17881	17.0
2623	29881	17.0
5319	28790	17.0
1649	39020	17.0
1837	39020	17.0

Existing hydrogen applications in Flanders



Status realization CtC project

■ Science & Technology (R&D):

- R&D subsidy programmes are readily available: EFRO, VLAIO R&D and MIP ICON projects have generated required technical solutions, as a results first installations are permitted and ready-to-be-built

■ Awareness & buy-in:

- Quadruple helix model deployed since 2009: growing awareness and buy-in on all levels (local <-> super local, Belgium <-> Europe), but unfortunately appeals from isolated individuals pose a real threat

■ Planning & permitting:

- Long, complex and expensive set of procedures have led to all required permits, which will most likely be destroyed by higher court due to appeals from these isolated individuals

■ Legal appeals:

- Higher court assesses permits and all included decisions from a content point of view, going much further than securing that no procedural errors are made
- Hard protection of nature is at this moment only parameter being considered in this assessment
- Temporary local removal of nature in order to create a higher total nature value is not allowed
- Upsides like creation of nature park, recovery of resources & energy and employment are not being considered

■ Financing:

- Lack of ELFM legislation jeopardizes financial close of project as framework for ELFM is not available

■ Legislation:

- EC poses that ELFM can be performed as long as relevant EU (landfill) directives articles are being adhered to
- Much better would be to have an unambiguous definition and framework included in EU directives

Opportunities towards a sustainable implementation

- Best possible short term interim use will be explored as soon as final judgments are known
- Continuity of Remo landfill operation is imperative to be able to continue the development of CtC

