Project Life+ 2009

Bio.Lea.R

Biogas Leachate Recovery

The project

Biolear is a joint venture of GAIA SpA and Politecnico di Torino to develop a system of leachate re-circulation of within a municipal waste landfill (project funded by EU – Life + 2010)

The main objectives are:
- to enhance the production of biogas for electrical power supply purposes;
- to decrease the time and environmental impact of the post-closure management of the landfill.

Bio.Lea.R

The phases of the project

Step 1

- Pre-design of the system
- (preliminary design of circulation system and monitoring devices)

Step 2

- Design of the wells, pipelines, recirculation system, monitoring of biogas and monitoring of infiltration
- (2010-2011)

Step 3

- Installation of leachate circulation system (wells and pipelines), new biogas wells, monitoring of leachate and biogas, installation of geophysical sensors
- (2011-2012)

Bio.Lea.R

The phases of the project

Step 4

- Characterisation of waste, laboratory test, preliminary geophysical characterisation of the landfill
- (2011-2012)

Step 5

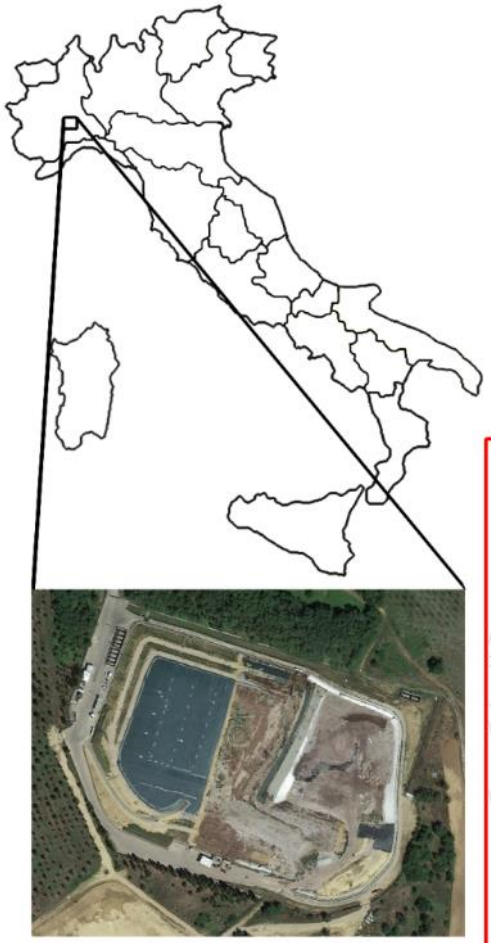
- Start-up of the re-circulation system, infiltration tests
- (2013)

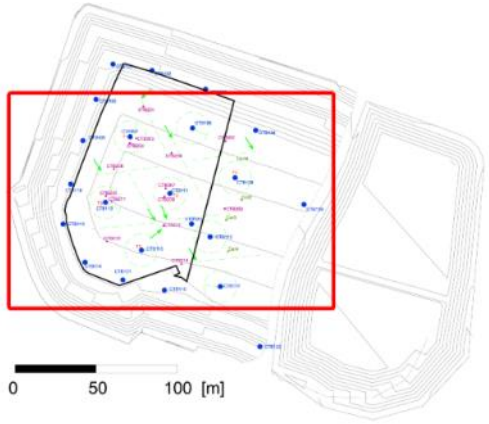
Step 6

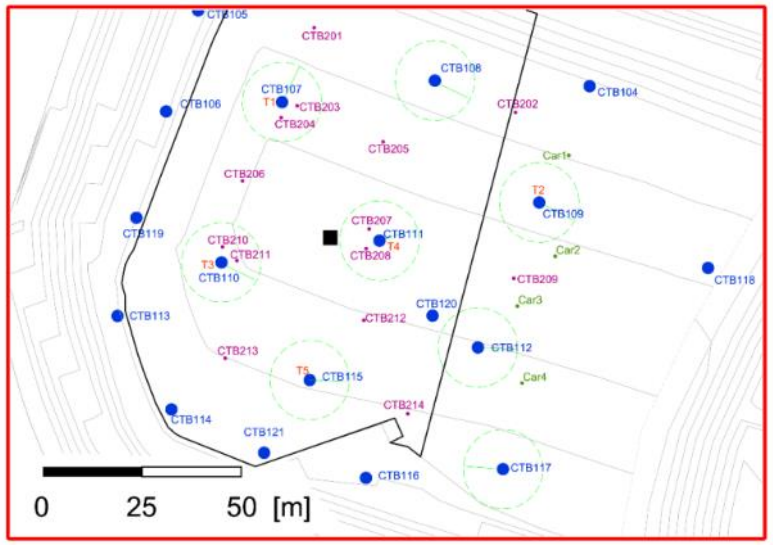
- Inejction at different points and monitoring of the response at several wells of biogas exctraction
- (from begining 2014….)

Bio.Lea.R

The site

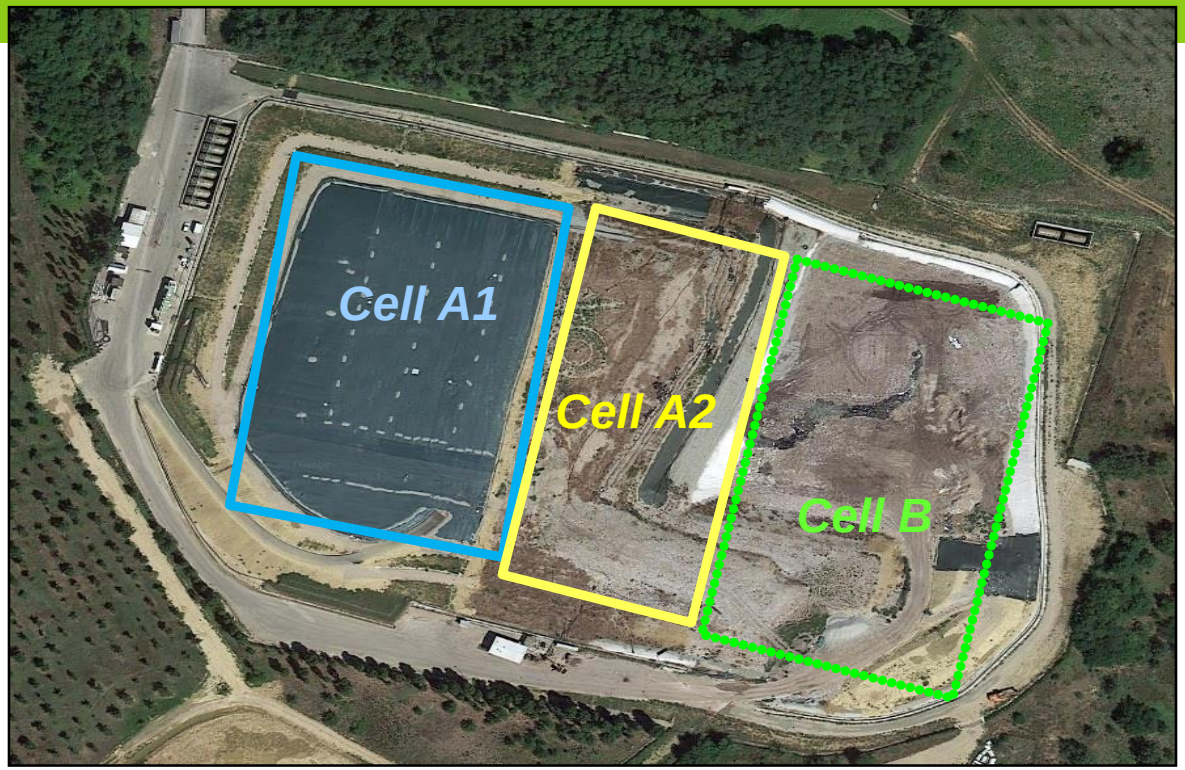






Bio.Lea.R

The Landfill



Landfill

- *Total volume: 660.000 m^3*
- *Active since 01/2004*
- *An annual average waste disposal of 40.000 t*

Cell A1 bio-reactor

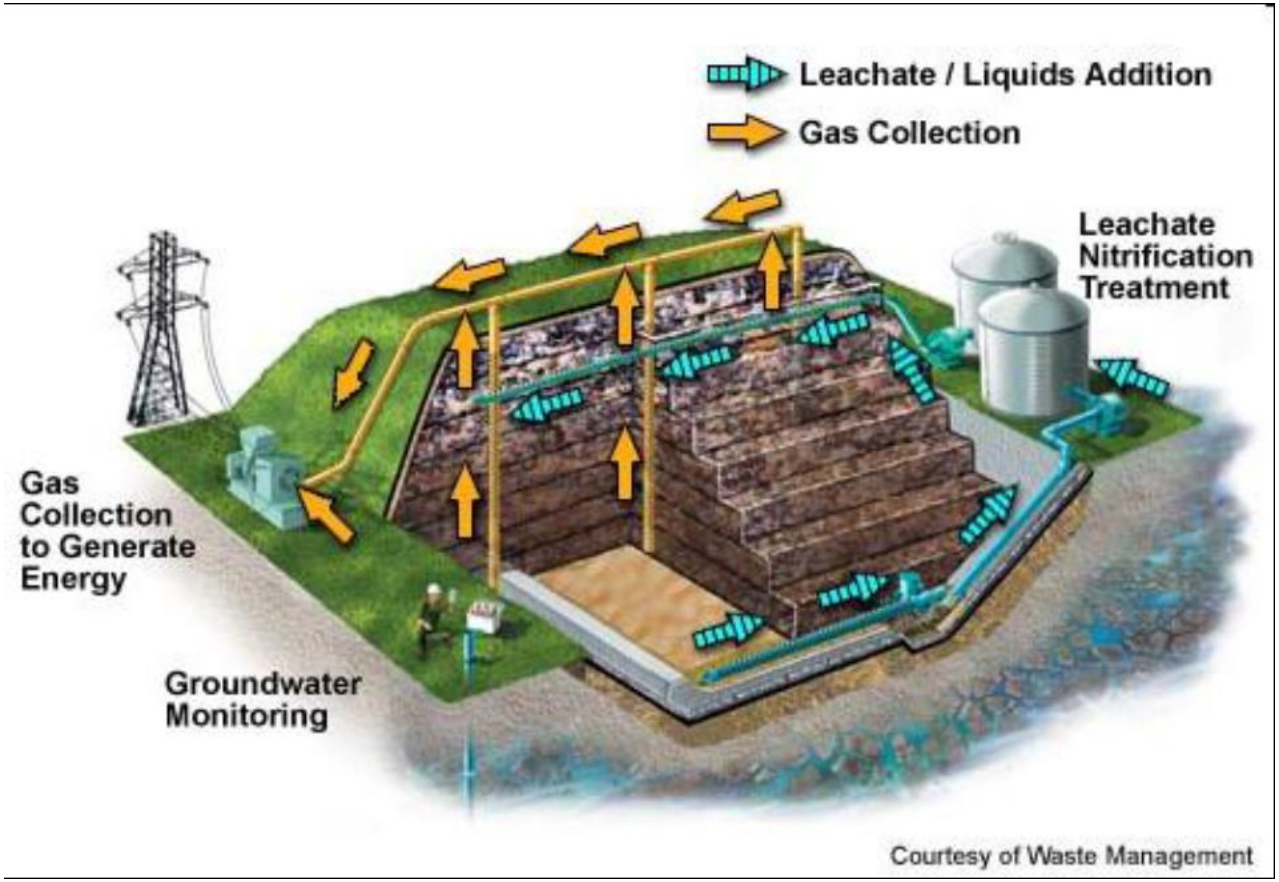
- *Volume: 360.000 m^3*
- *Capping 06/2013*
- *MWS pre-treated (TMB)*

Bio.Lea.R

The basic concept of landfill as bioreactor

Liquid and biogas within the landfill are actively controlled in order to speed up the bio-stabilization of the wastes

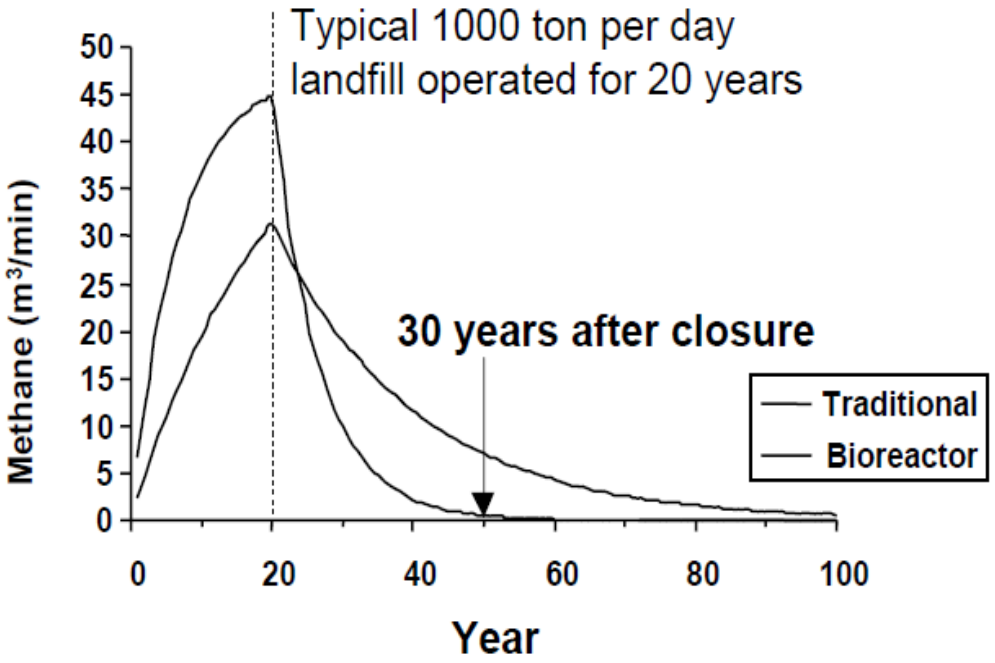
The landfill as bioreactor increases the waste decomposition with respect to the rate of degradation of a conventional landfill



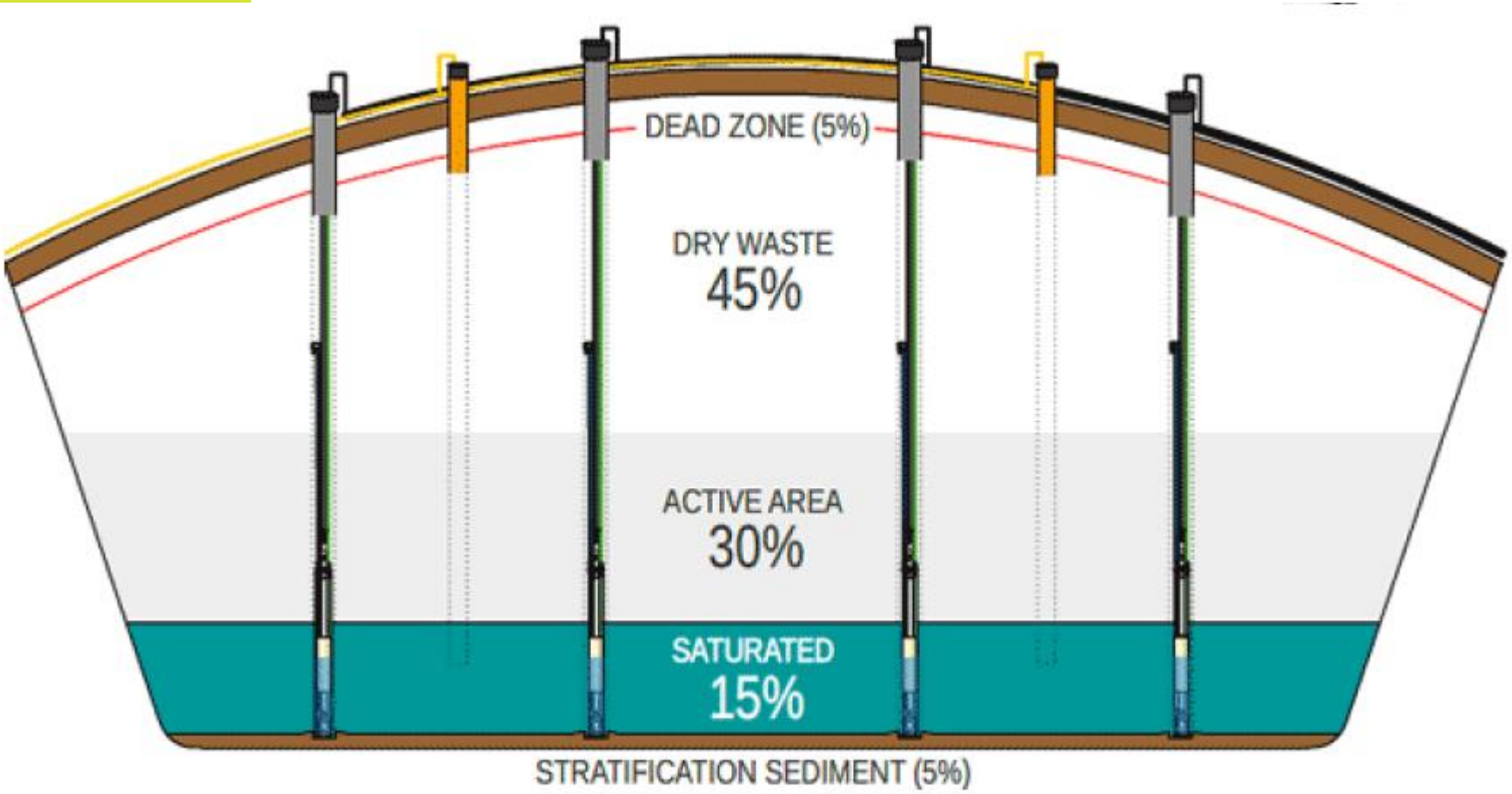
Advantages

- Increases the volume available to store new waste material because a faster settlement of the old waste is achieved
- Enhances the flexibility in the management of the leachate
- Increases the biogas production
- Decreases the impact of the potential pollution
- Decreases the risk and costs of the post-closure activity

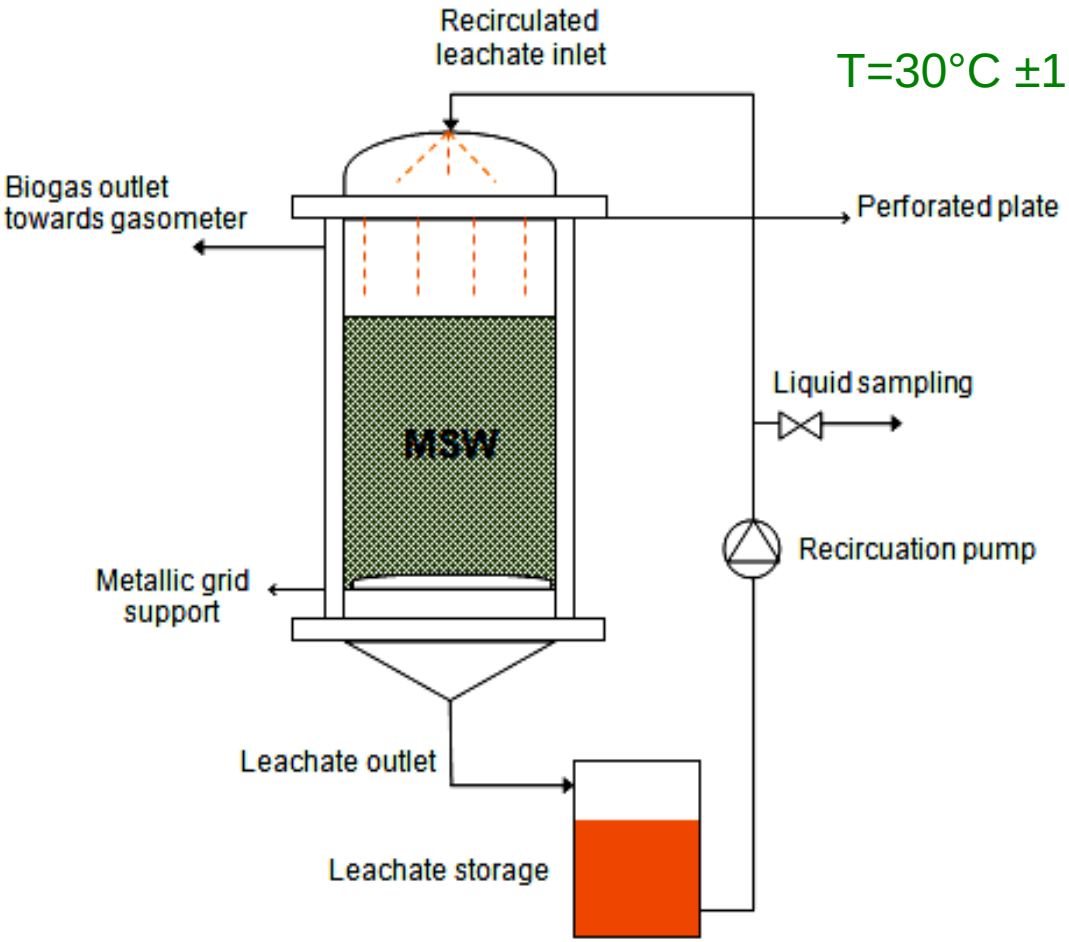
- Sustainability of the management of waste landfill



The conceptual model of the landfill



Laboratory simulation

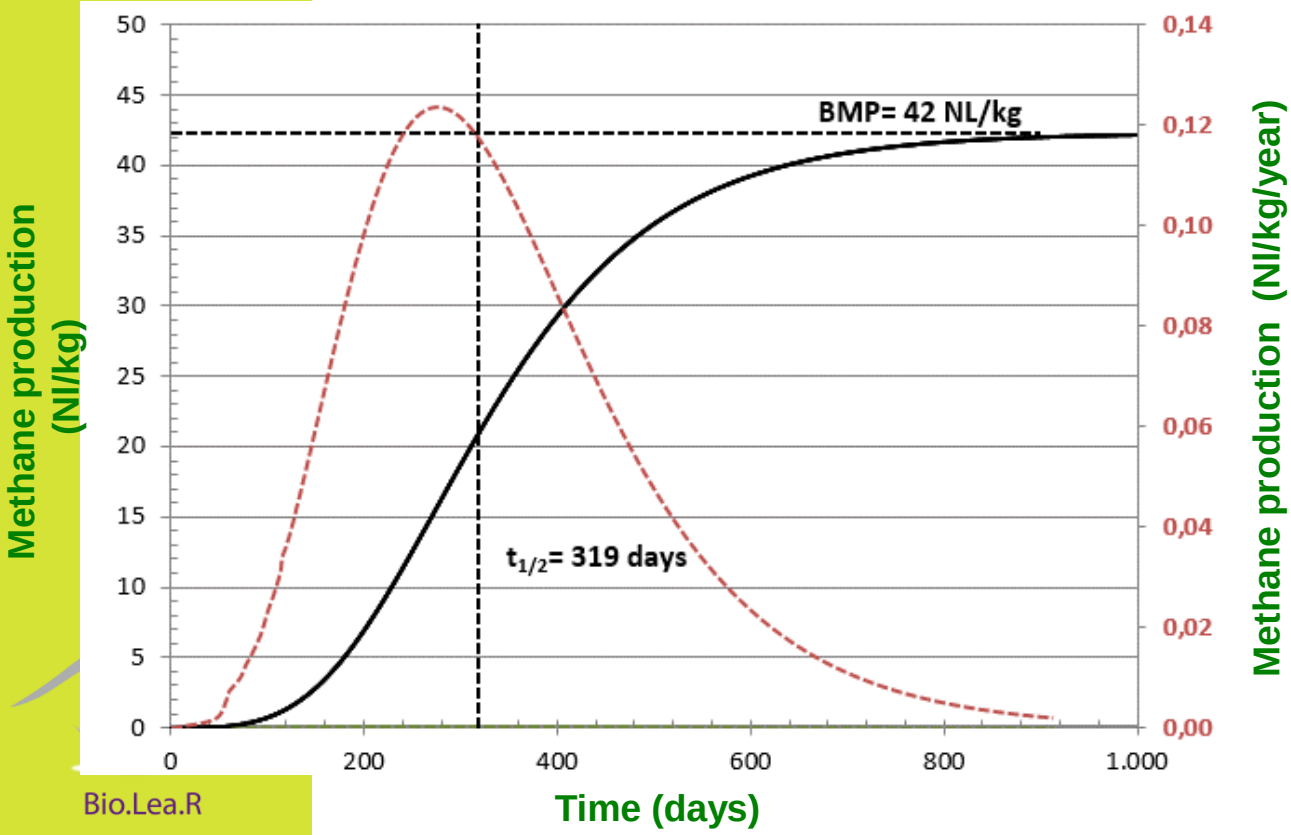


T=30°C ±1°C

Laboratory simulation

Fitting of experimental data by means of the Gompertz equation

$$BM = BMPexp\left\{-exp\left[\frac{R_m \cdot e}{BMP}(\lambda - t) + 1\right]\right\}$$



Umidity

40 % → 60 %

Humidity

Kinetic

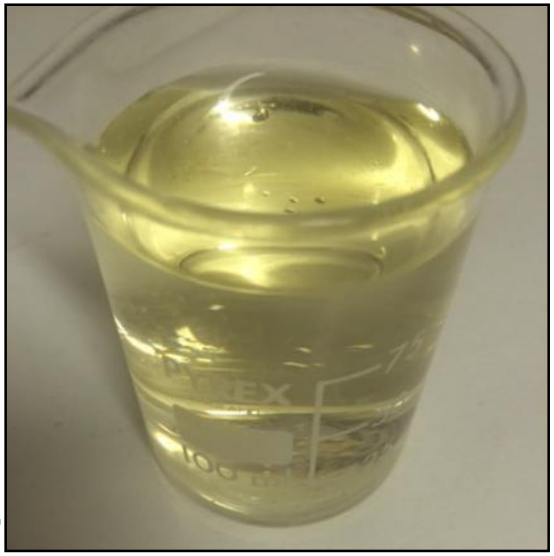
Bio.Lea.R

Laboratory simulation

Leachate …. before

COD

2000 mg/l …. 80 mg/l



Leachate.... After

Bio.Lea.R

Experimental set-up

Devices for biogas treatment

The leachate re-circulation system

Laboratory simulation

In situ physical and chemical monitoring

Bio.Lea.R

Leachate re-circulation system

The injection system is mainly composed by:

- 8 rings of 20 m diameter for horizontal injection centered on
- 8 pipelines (horizontal injection)
- 4 wells for vertical injections
- Leachate pumping system
- Extraction pumping system from the bottom of the cell
- Two tanks for the leachate storage (400 m^3)

The injection system

Bio.Lea.R

Monitoring

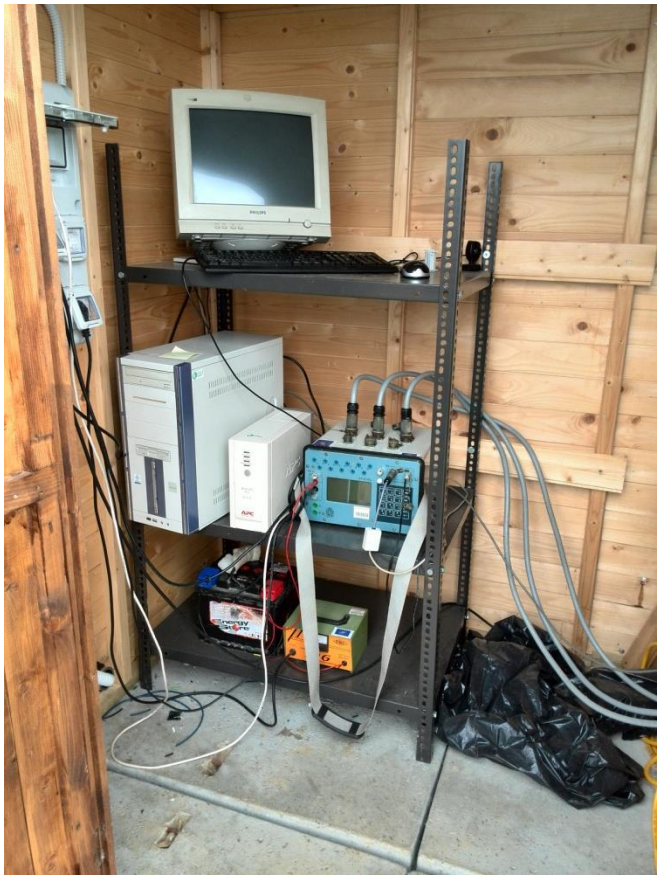
- Temperature sensors;
- Geophysical sensors to monitor the electrical conductivity/resistivity of waste (from top up to depth of 15 m)
- In line analysis of biogas quality
- Physical and chemical parameters of the inflow and outflow of leachate

The monitoring of biogas

The wellhead of the injection system

Bio.Lea.R

Geophysical real time monitoring



The device controls simultaneously the geophysical sensors distributed along 8 different wells within the reactor

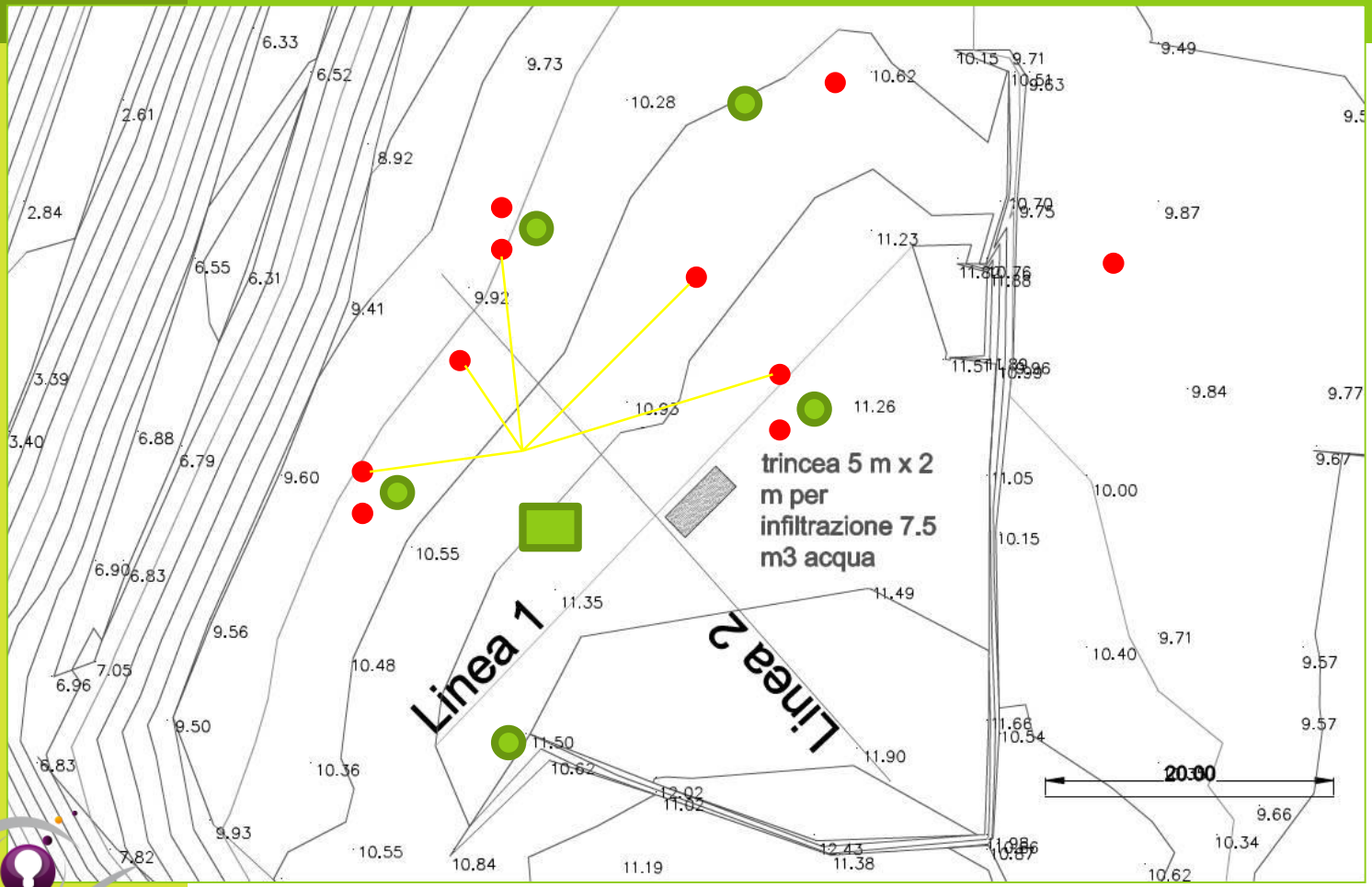
The main goal is to monitor the infiltration and distribution of the re-circulation water.

Bio.Lea.R

The monitoring devices

Bio.Lea.R

The network of boreholes for the geophysical monitoring



Wells addressed with electrodes

Temperature sensors

Bio.Lea.R

Infiltration test (Jan. 14): Rate of injection

Day	Inj. Hours per day	m3/h	Tot m3/d
14/01	7	5.9	41.3
15/01	8.30	5.1	43.3
16/01	6.30	4.8	31.2
17/01	6.30	4.8	31.2

Monitoring: ERT –electrical reistivity tomography in cross-hole configuration

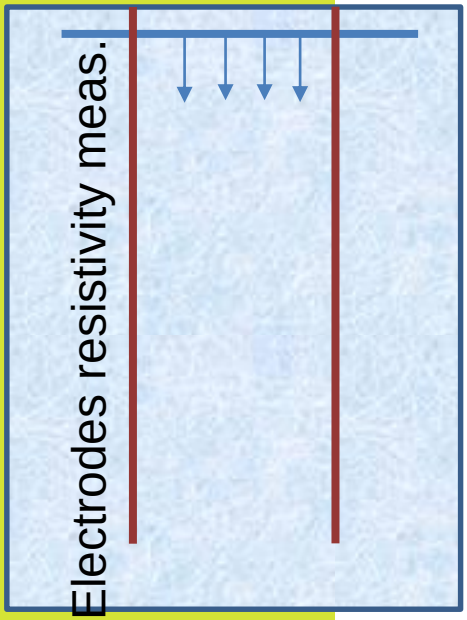
Electrical resistivity is sensitive to fluid content, fluid salinity, temperature and interface phenomena between solid and fluids
Changes of electrical resistivity can be related to change of waste humidity

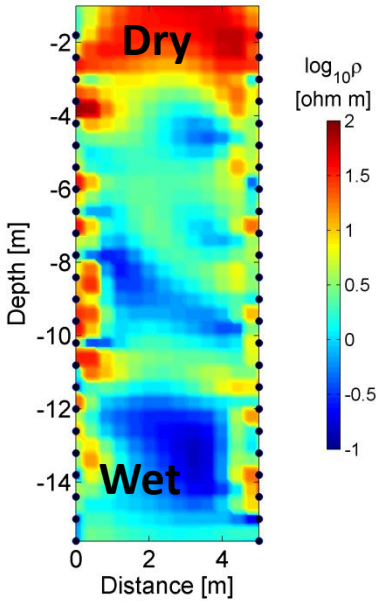
Bio.Lea.R

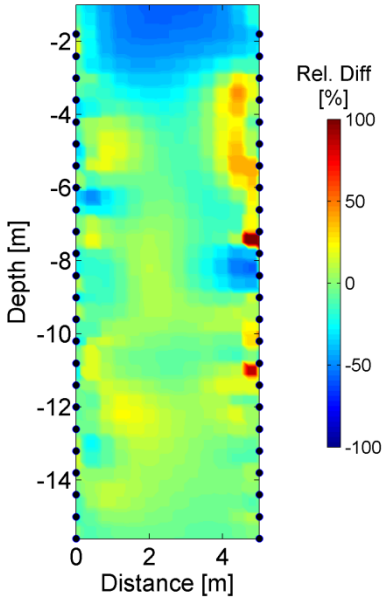
Distribution of electrical resistivity on vertical section

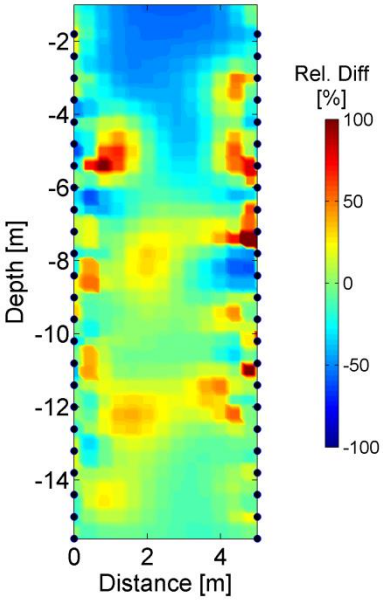
Day14/01

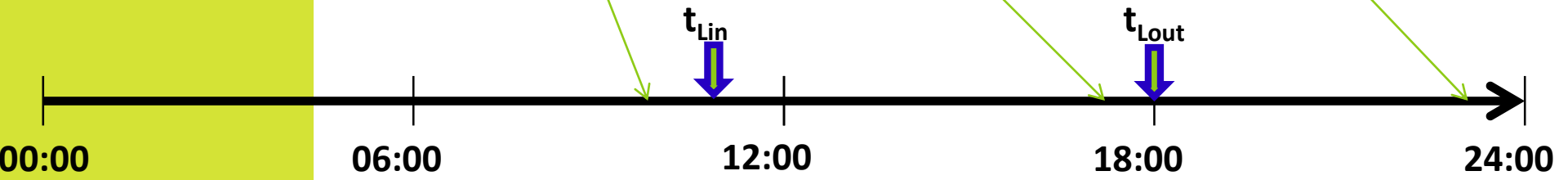
Injection ring/pipeline



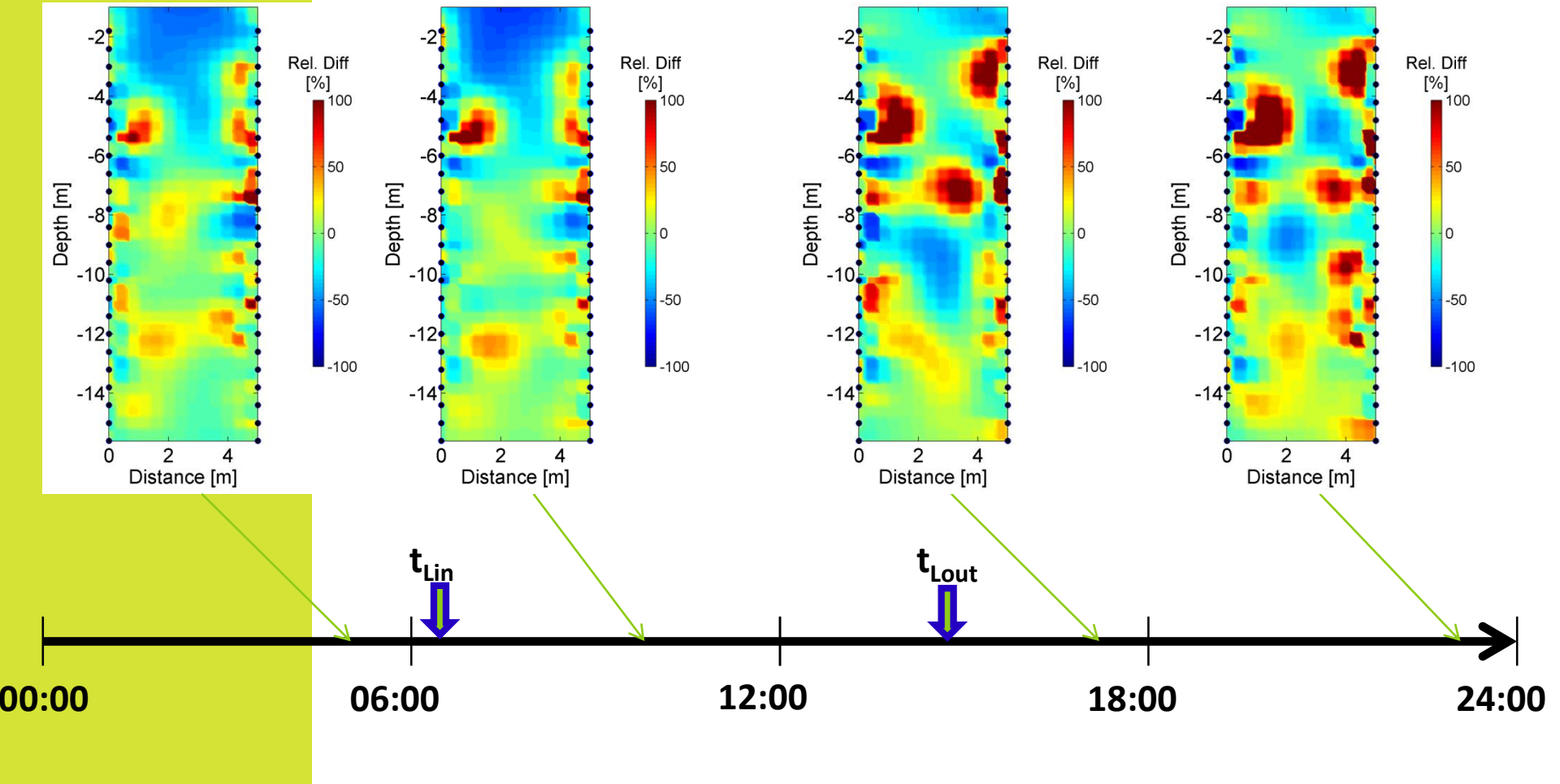






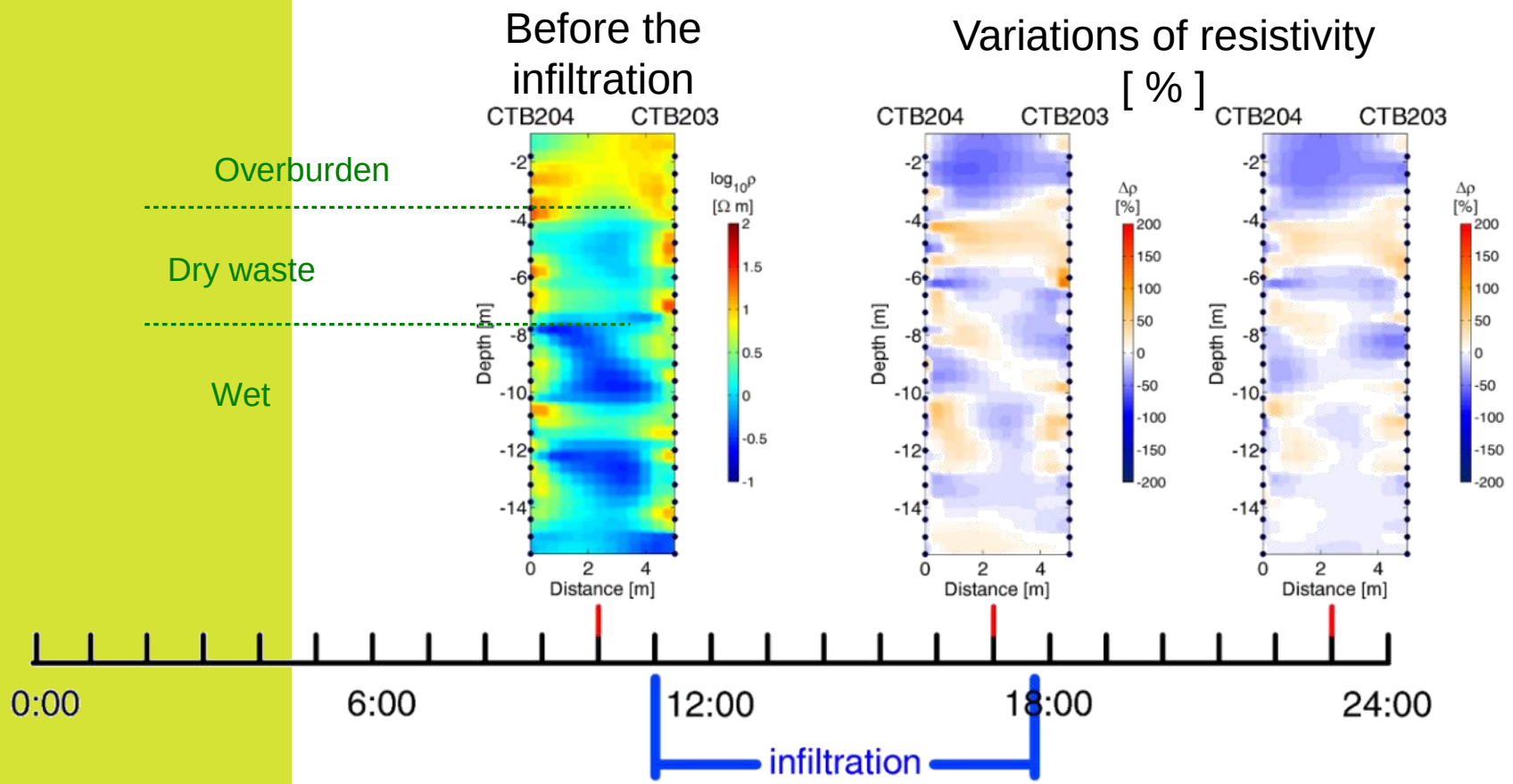


Day 15/01

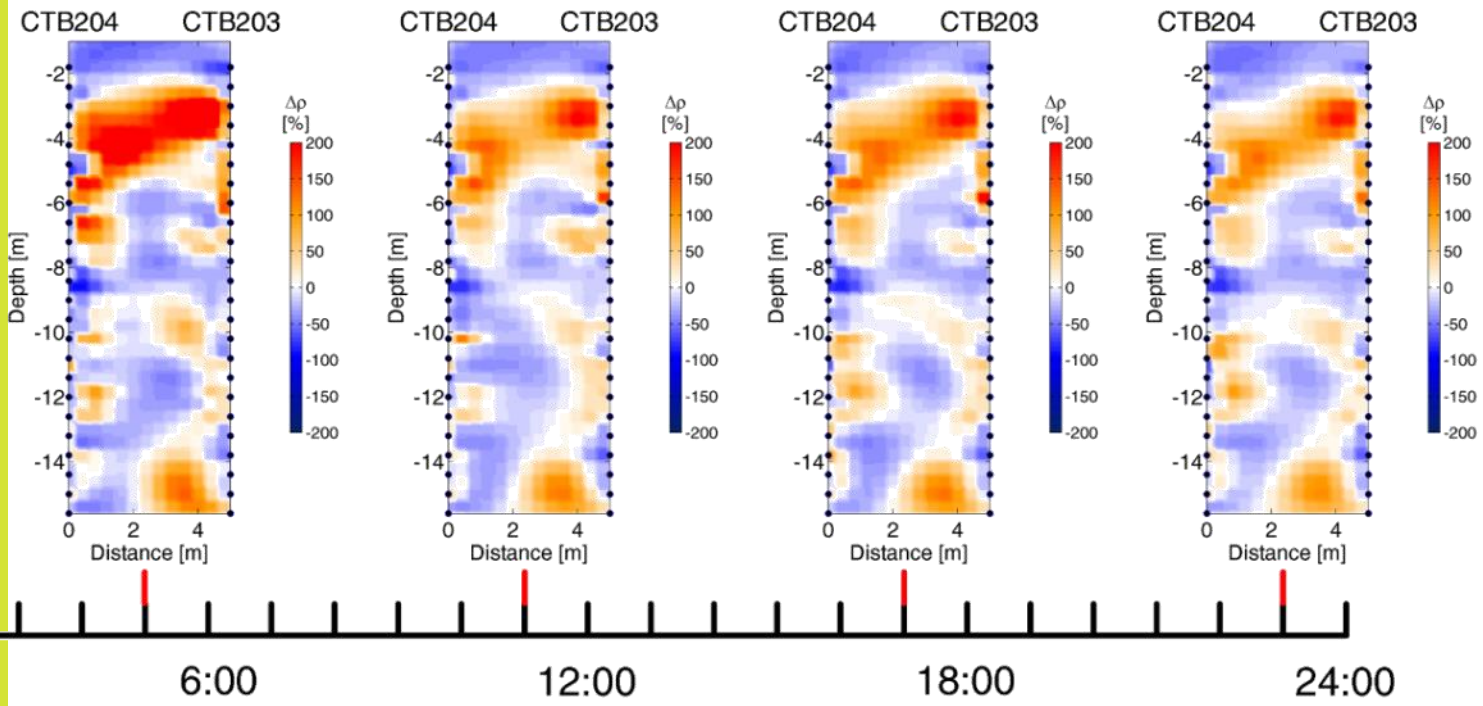

Depth [m]
Distance [m]
Rel. Diff [%]
100
50
0
-50
-100
t_{Lin}
t_{Lout}
00:00
06:00
12:00
18:00
24:00

Results of geophysical monitoring

Example of distribution of electrical resistivity between wells CTB 203 e 204, close to the infiltration well n.107

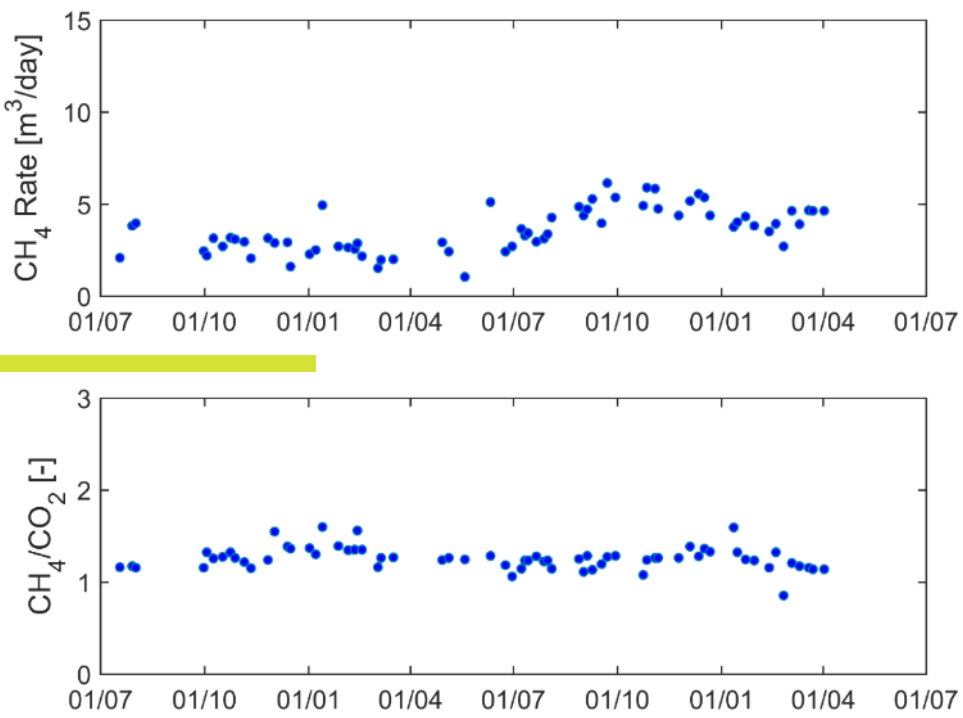


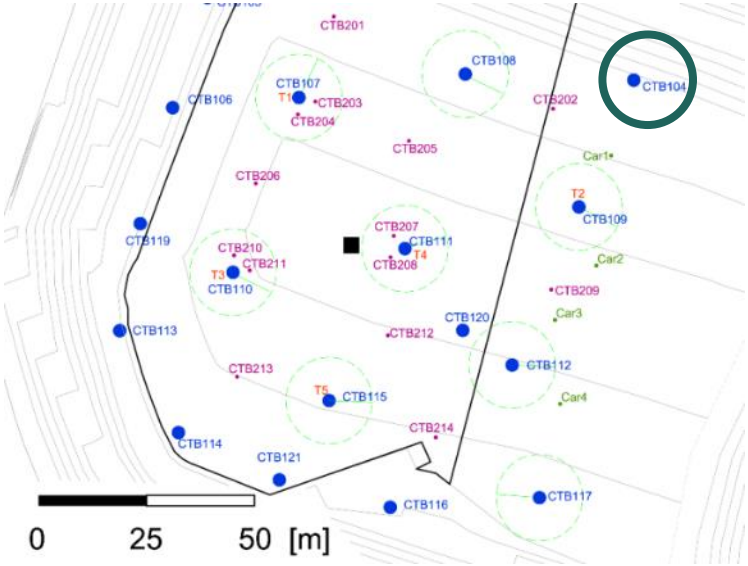
Results of geophysical monitoring



Bio.Lea.R

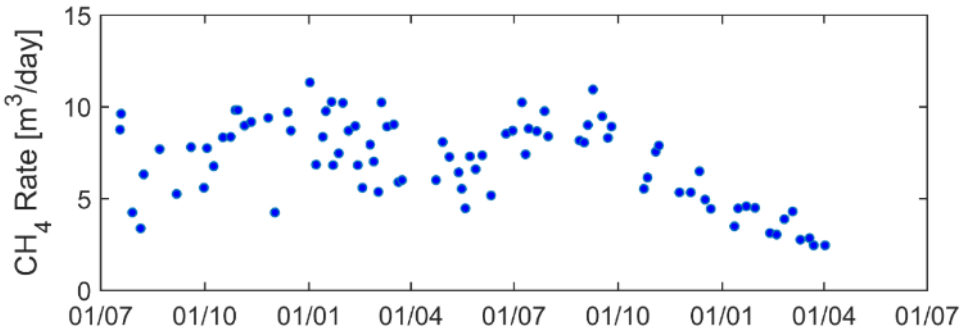
Results – Biogas
Well outside the bioreactor

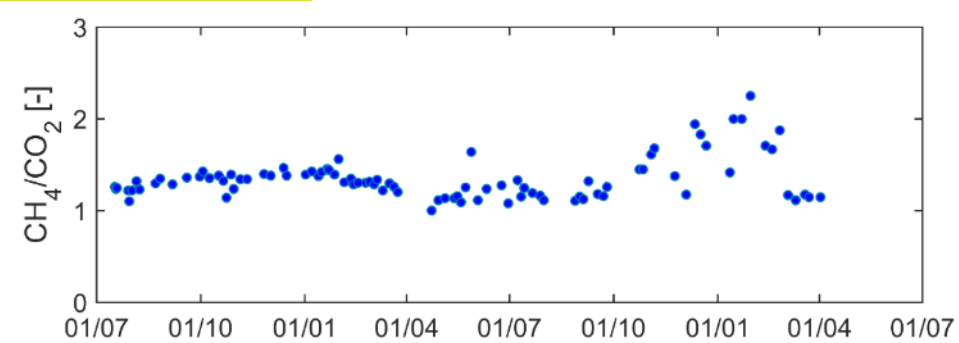


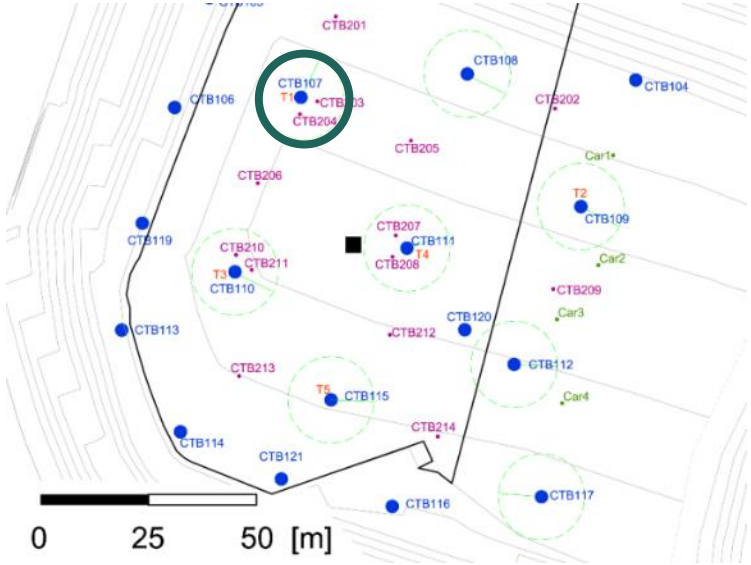


Bio.Lea.R

Results – Biogas
Well within the bioreactor

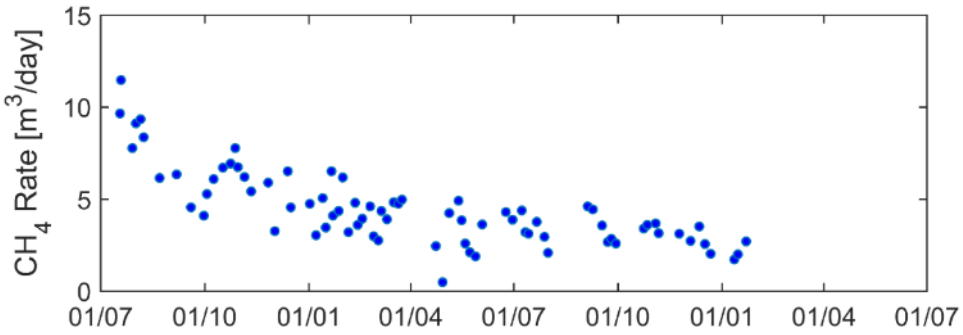


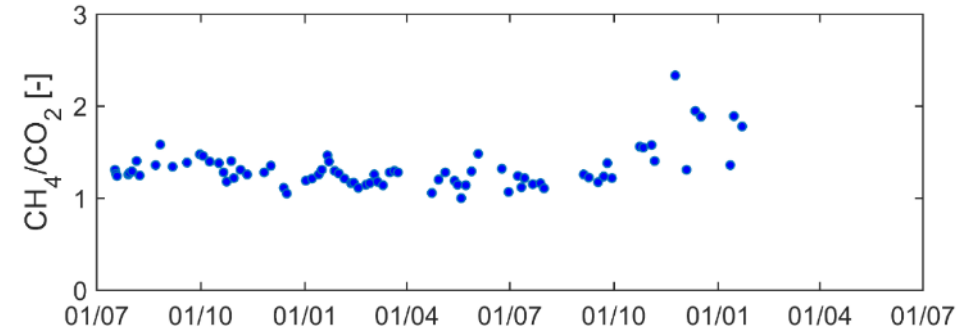


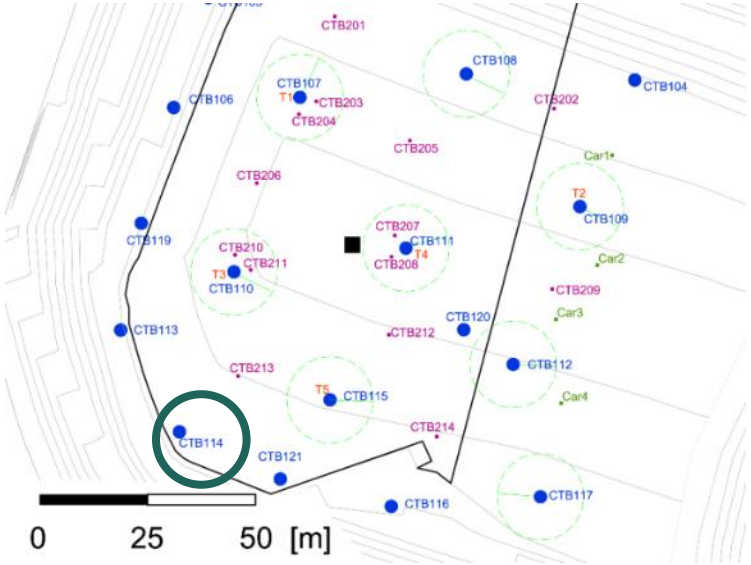


Bio.Lea.R

Results – Biogas
Well within the bioreactor







We don't observe an increase of the biogas production but the activity of bio-degradation has been enhanced

Bio.Lea.R

Results

Industrials

Optimisation of the technology of leachate re-circulation

Scientifics

Development of new technologies for in-line monitoring of biogas

Optimisation of geophysical monitoring for the analisys of infiltration processes

Pubblications

Godio A., Arato A. Chiampo F., Ruggeri B., Di Addario M., Fischetti M., Perissinotto E. 2014. Liquid injection to enhance biogas production in landfill for pretreated municipal solid wastes Bio.Lea.R. Project (LIFE+ Program), Journal of Waste managemenet (in press)

Di Addario M., Ruggeri B., Chiampo F. 2014. Enhanced biogas production of low biodegradable fraction of municipal solid waste via leachate recirculation: experimental simulation

Arato A., Agostini E., Godio A. 2014. Geo-electrical characterization and monitoring of a waste landfill for its future exploitation as a bioreactor. Near Surface Geoscience 2014 Tu PA1 11

References

- **http://www.biolear.eu**

- ITRC Technical and Regulatory Guideline for Characterization, Design, Construction, and Monitoring of Bioreactor Landfills" is available at www.itrcweb.org under "Guidance Documents" and "Alternative Landfill Technology."

- http://www.clu-in.org/conf/itrc/bioreactors/resource.cfm