



LANDFILL METHANE REMOVAL LATIN AMERICA EXAMPLES

Paris, 9th November 2015



DECENTRALIZED ORGANIZATION SERVING OUR CUSTOMERS

179,000
employees on 5 continents

€23,880
million revenue

NORTH AMERICA
€2,020 million revenue
9,000 employees

LATIN AMERICA
€895 million revenue
14,100 employees

FRANCE
€9,305 million revenue
53,000 employees

**AFRICA
MIDDLE EAST**
€1,810 million revenue
12,000 employees

EUROPE
€7,680 million revenue
65,300 employees

ASIA / OCEANIA
€2,170 million revenue
25,600 employees



VEOLIA DESIGNS AND DEPLOYS CIRCULAR ECONOMY SOLUTIONS FOR **WATER**, **WASTE** AND **ENERGY** MANAGEMENT TO IMPROVE EFFICIENCY FOR CITIES, INDUSTRY AND CITIZENS.



OUR COMMITMENTS FOR SUSTAINABLE GLOBAL AND REGIONAL DEVELOPMENT



6.8 M
tons equiv. CO₂ avoided

15.3 M
tons equiv. CO₂ reduced



25%
share of renewable or alternative energies in the Group's energy production

Our vocation of “Resourcing the world” is reflected in our commitments to the sustainable development of people, regions and the planet, in particular:



IMPROVING
access to essential services for all the populations we serve, including the most underprivileged, by offering access conditions adapted to local circumstances.



REDUCING THE ENVIRONMENTAL FOOTPRINT,
in particular through optimal resource management and reductions in CO₂ emissions contributing to combating climate change.



PRESERVING AND RESTORING BIODIVERSITY
by maintaining and enhancing the services provided by ecosystems in the course of our operations.

WASTE MANAGEMENT



- 10,140 M € sales
- 105,267 employees
- Activity in 32 countries



- 66.6 MT of waste treated
- 45.9 MT of waste collected
- 715 treatment plants operated



- 79.6 M inhabitants served
- 801,000 industrial customers

WASTE TREATMENT PLANTS

715 Treatment Plants in 2013

36 Plants Special Waste Recycling

54 Chemical physical treatment plants for special waste

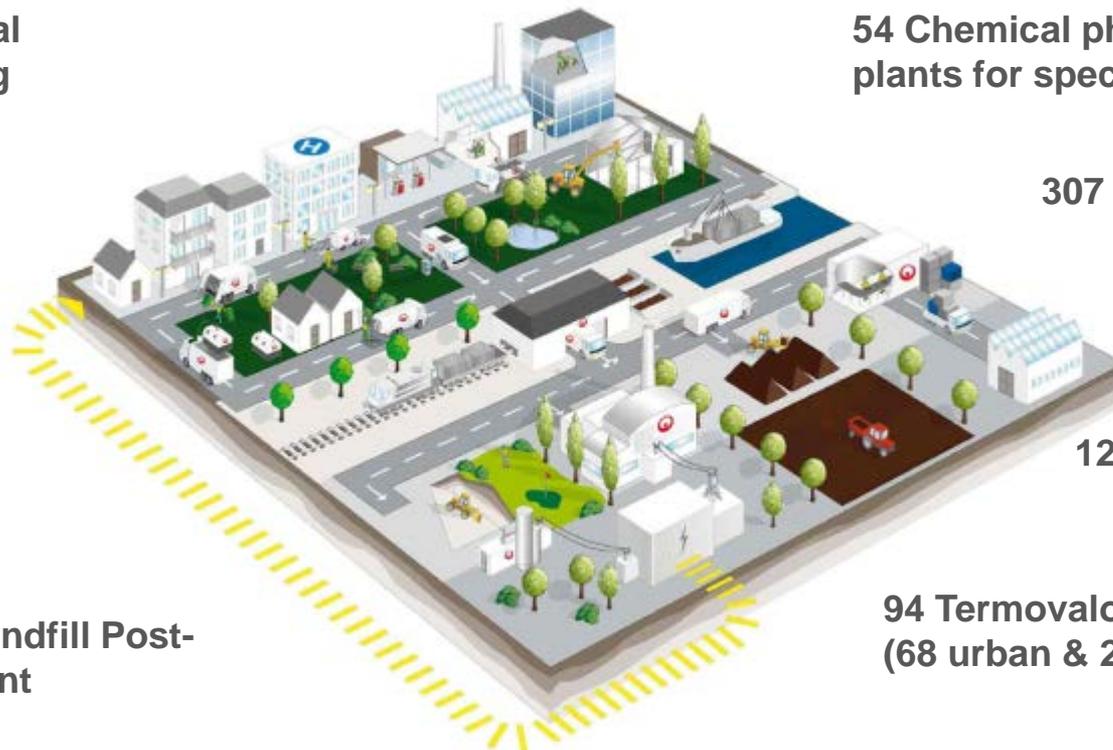
307 Recycling Plants

12 Units of Soil Decontamination

122 Composting Plant

133 + 68 Landfill Post-management

94 Termovalorization plants (68 urban & 26 specials)



955 ISO 14001 ISO 9001 & 1299 certified plants
84% of sales from activities ISO 9001 and ISO 14001 certified

LANDFILL GAS TO ENERGY PROJECTS IN LATIN AMERICA



BIOGAS DOÑA JUANA CERs CONTRACT

*Doña Juana landfill – 6.000 ton/day
(Bogotá, Colombia)*

2007: ONE OF THE BIGGEST CERs CONTRACT



DOÑA JUANA BIOGÁS

- 6,000 tons/day landfilled (one of the biggest in the world).
- Biogas treatment: 15.000 m³/h
- Biogas Project: reduce over the next 20 years the GHG emission by more than 14 million tons of CO₂ equivalent.

Flaring



Collection



Electricity generation



2009: BIOGAS FLOW 15.000 Nm³/h @ 52% CH₄

Client: UAESP (Bogotá's municipal subsidiary responsible of waste management)

Landfill: Doña Juana (Bogotá's landfill). Owned by UAESP.

Bid mechanism: International bid.

Contractual conditions:

- Revenues from CERs sale.
- 24% of CERs paid to client.

Consortium:

- 50% Veolia / 50% Gas Natural SDG.
- Length of contract: 23 years.

Technical characteristics:

- Landfill tonnage: 6.000 tons / day
- Collection and flaring: 15.000 Nm³/h.
- Electrical generation: 600 kW



2011: CERs PRICE COLLAPSE

Contract timeline:

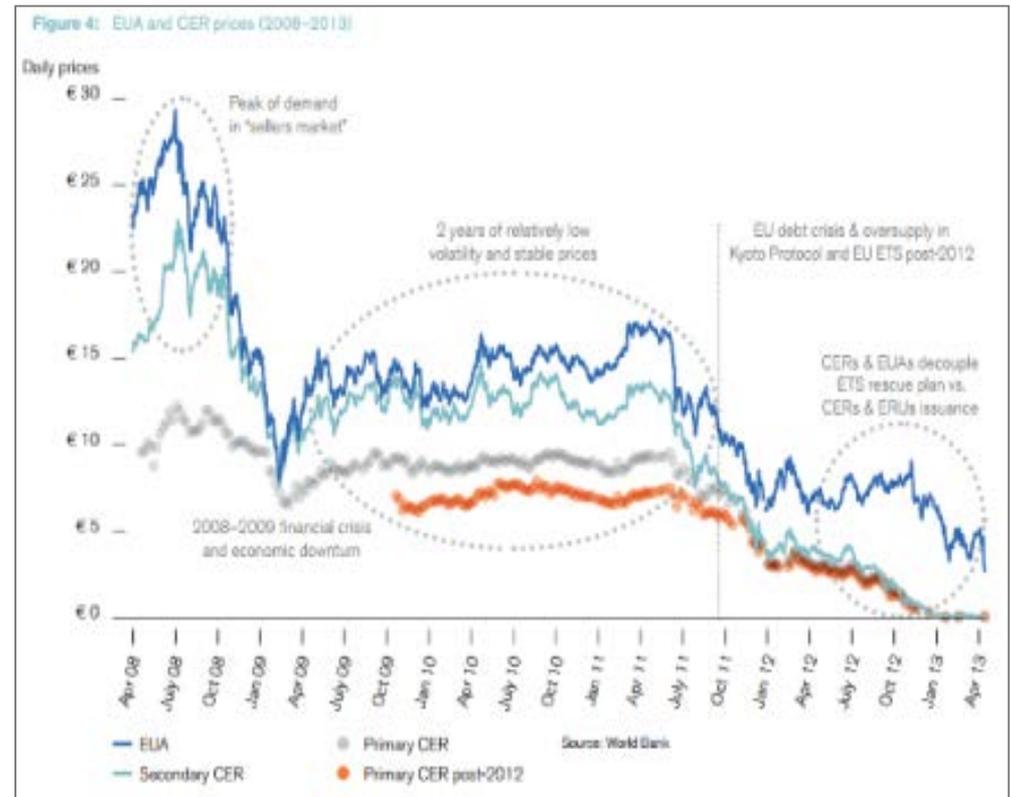
- 2007: Contract signed.
- 2009: Operations start up.
- 2011: CERs market collapse:
 - a) 2007: Market prices: $\approx 21 \text{ € / CER}$.
 - b) 2011: Market prices: $< 4 \text{ € / CER}$

Other alternatives analyzed:

- Brick producers around the landfill use very low cost coal – lack of price competitiveness-.
- Complexity to obtain permissions to furnish electricity to local networks & low energy prices – lack of price competitiveness-.

Conclusion:

- No economical viability of the contract.
- 2013: sale of project to an energy producer.



LA BONANZA COLLECTION & FLARING

*La Bonanza landfill – 4.000 ton/day
(Caracas, Venezuela)*

WASTE DISPOSAL CONCESSION 4.000 TONS / DAY



LA BONANZA LANDFILL:

- It serves 11 municipalities: The 5 most populated municipalities of Caracas and six municipalities of the Valles del Tuy.
- 4.5 million inhabitants
- 1.54 million tons of MSW



Client: Gobierno Distrito Capital
(Caracas´municipal subsidiary responsible of waste management)

Landfill: La Bonanza (Caracas´landfill).
Concession.

Contractual obligations: biogas collection & flaring

Consortium: 51% Veolia / 49% Hnos Salas

Technical characteristics:

- Landfill tonnage: 4.000 tons/day
- Collection and flaring: 6.000 Nm³/h

COLLECTION & FLARING AS UNIQUE ECONOMICAL ALTERNATIVE

Electricity very subsidized: 3 €/MWh

Conclusion: lack of financial feasibility for making use of biogas internal energy

Even leachate evaporation is more economical with external fuel supply.



"Manifold" for LFG active flaring regulation



Low Cost "Elevated flare"



BIOGAS FLOW: 6.000 Nm³/ h @ 55 CH₄



ESTACIÓN DE REGULACIÓN
(ER)

CP-XX **
Chimeneas ⚠ : Volver a medir la producción luego de la adecuación y conectar si producción de biogás es > 5 Nm³/h con 50% CH₄

CONVENCIONES

⚠-XX	Chimenea Perforada construida existente a la fecha	●	Punto Bajo	G63	Tubo #63mm
⚠-XX	Chimenea Gavión construida existente a la fecha	●	Punto Alto	G110	Tubo #110mm
DPS-XX	Salida biogás Drenaje Perimetral existente a la fecha	●		G160	Tubo #160mm
⚠-XX	Chimenea Perforada no existente a la fecha	●		G200	Tubo #200mm
⚠-XX	Chimenea Gavión no existente a la fecha	●		G250	Tubo #250mm
⚠-XX *	Chimeneas sin conexión prevista	●		G315	Tubo #315mm
DPS-XX *	Producción biogás < 5 Nm ³ /h con 50% CH ₄				

PORTOBELLO DIRECT THERMAL VALORIZATION

*Tijuquinhas Landfill – 1.200 ton/day
(Biguaçu, Brazil)*

2008: CERs PROJECT



TIJUQUINHAS LANDFILL

- Tonnage: 1,127 ton/day
- 3.000 Nm³/h @ 53% CH₄



Client: Landfill privately owned.

Landfill: Tijuquinhos (Santa Catarina region) landfill.

2008: CDM project

- LFG flaring project registered in 2008
- More than 6 years of LFG capture & flaring operation. & monitoring
- Current CDM revenues insufficient to cover network and operation costs

URGENT SEARCH FOR ALTERNATIVES

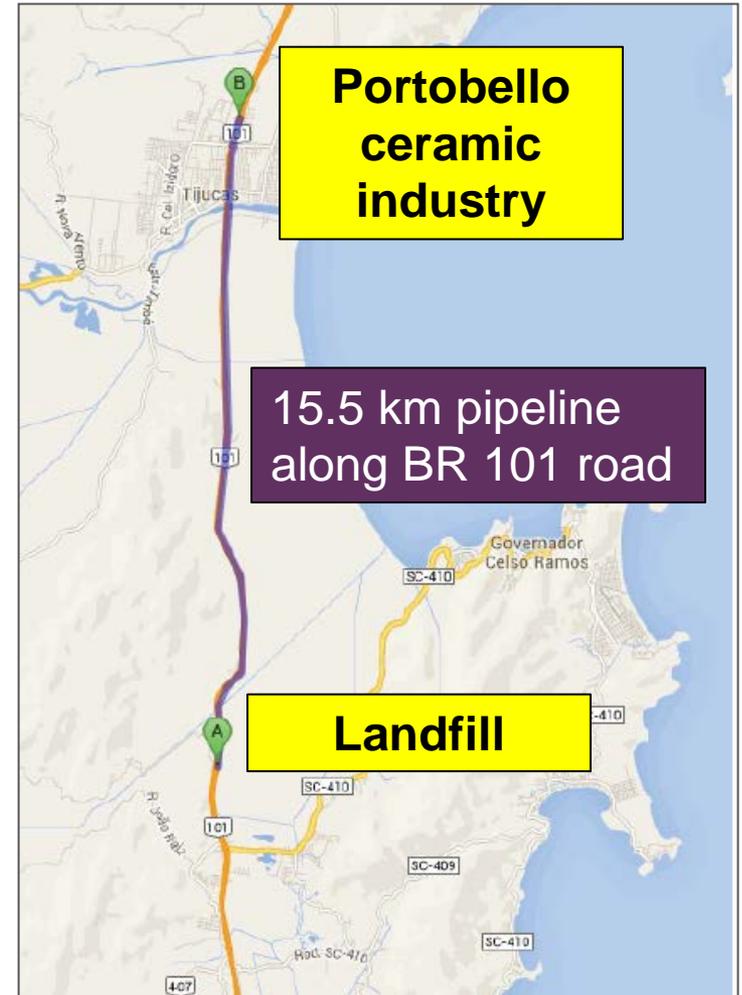
PORTOBELLO CERAMIC INDUSTRY

LANDFILL COMPRESSION PLANT

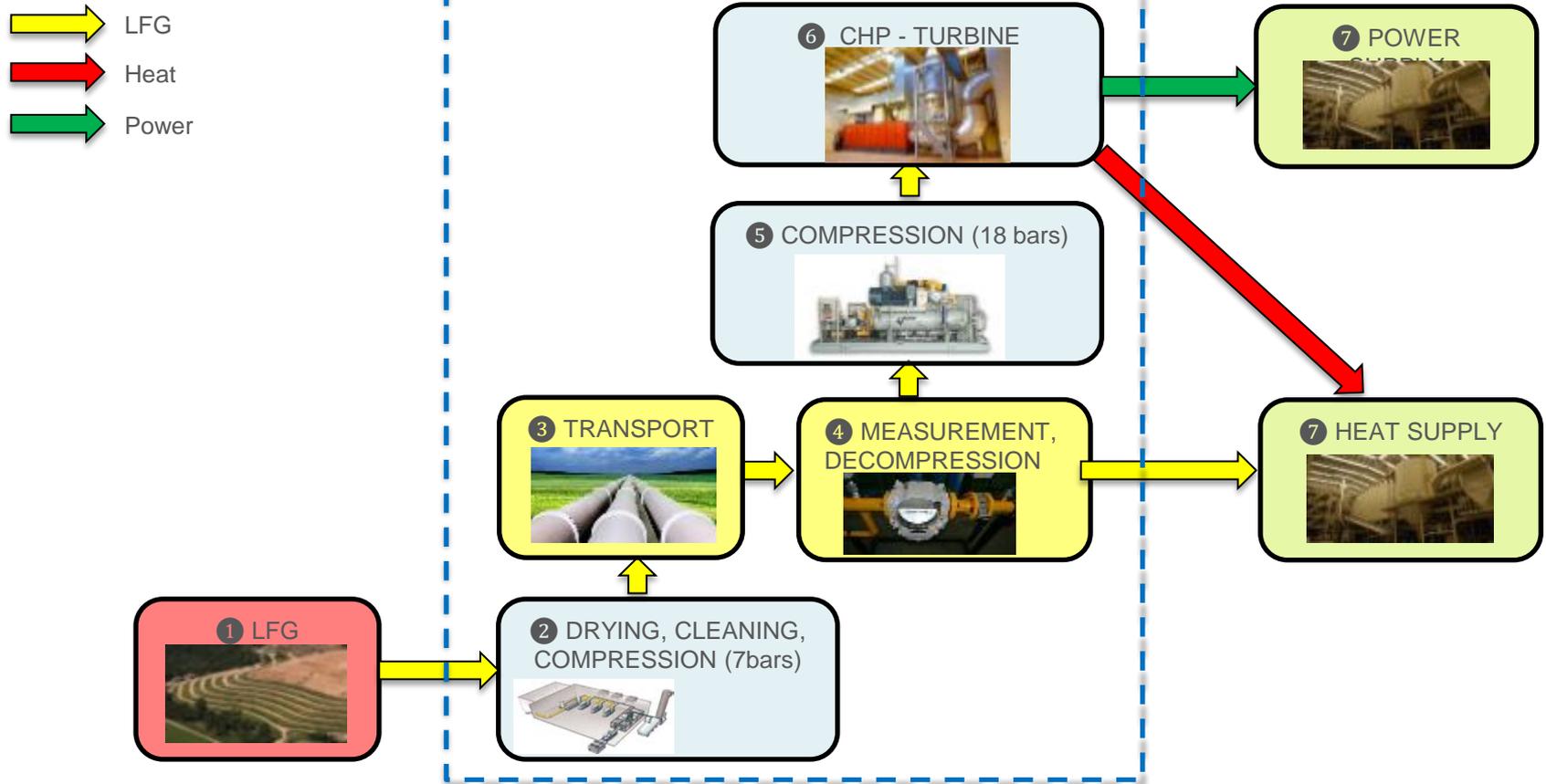
- 3 screw compressors MYCOM (7.5 bars)
- 1 chiller
- air coolers
- 1 odorization system
- LFG connexion pipeline
- 1 injection station
- 1 LFG engine (1 MW)

PORTOBELLO CHP PLANT

- 3 screw compressors MYCOM (18 bars)
- 2 turbines (SOLAR 2 x 5.5 MW)
- LFG connexion pipeline
- Heat pipes to atomization
- LFG burners for atomization (in case of LFG direct use)



NEGOTIATIONS IN PROCESS



METROGAS BIOMETHANE PRODUCTION

*Santiago Poniente landfill – 2.000 ton/day
(Santiago de Chile, Chile)*

SANTIAGO DE CHILE 3rd LARGEST LANDFILL



SANTIAGO PONIENTE LANDFILL

- 40,000 t / month of non-hazardous waste.
- For 600.000 inhabitants
- 22 years contract.

Client: Privately owned landfill.

Landfill: 3rd Santiago de Chile landfill.

Technical characteristics:

- Tonnage: 2.000 Tn/day
- Collection & flaring: 3.000 Nm³/day

Alternatives analyzed to make use of biogas internal energy

- Heat utilization. No customers close to the landfill.
- Electricity generation. Strict NO_x local emissions that make expensive this alternative.



QUERETARO ELECTRICITY & CERs

*Querétaro Landfill – 1.000 ton/day
(Querétaro, Mexico)*

COMPULSORY CREATION OF MUNICIPAL & PRIVATE OPERATOR COMPANY TO SELL ELECTRICITY



QUERÉTARO LANDFILL

- Term: 15 years from the signing of the concession (1996)
- Extends Term: 15 years from the signing (2006-2021)
- Population served: 800,000 inhabitants.
- Production: 850 ton / day
- Service with volumes of 1,800,000 tEq.CO2 and 194,000 MW / h

In Mexico private companies cannot sale electricity to public electrical networks

2010: Incorporation of a municipal & landfill operator society (10% municipality / 90% operator) to produce electricity from biogas and sale of the electricity to the municipality.

Price for the municipality -9% @ use for street lighting tariffs.

Initially 12% of the revenues came from CERs sale.

2010 - 2015: Permits and authorizations from Mexico electrical regulators.

Biogas flow: 600 m³/h @ 54% CH₄



600 Nm³/h @ 54% CH₄



BUT
COMPLEXITY OF LANDFILL GAS TO
ENERGY PROJECTS IN LATIN
AMERICA

NO GENERAL RULES

Country	Populat. (millions)	% LatAm	GDP US\$ per capita	Landfill tariff (€/ ton)	Electricity price (€/ MWh)	Active collection & flaring compulsory or included in tariff	Ownership of biogas	Leachate treatment compulsory or included in tariff
Brazil	205	34%	12.300	20-25	50	No	Yes	Yes
Mexico	121	20%	15.900	10	100	No	No general rule	No
Colombia	48	8%	11.200	10-20	40-50	No	No general rule	No
Argentina	43	7%	18.700	10	5	No	Yes	Yes
Peru	31	5%	11.400	4	15	No	No general rule	No
Venezuela	30	5%	13.600	35	3	No	No general rule	Yes
Chile	18	3%	19.500	10-15	80	No	No general rule	Yes
TOTAL	485	81%	13.800	17				

COMPLEX FINANCIAL FEASIBILITY & SLOW DEPLOYMENT

■ COMPLEX LANDFILL GAS TO ENERGY PROJECTS

- High CAPEX/OPEX due to procedures and technical requirements.
- Economical & regulatory context don't facilitate LandFill Gas To Energy projects in LATAM.
- Technical, financial and regulatory restrictions do not help to the acceleration of these projects.

■ ALTERNATIVES

- a) Develop Landfill to gas energy projects → feasible, but slow.
- b) Remove methane in landfills through active collection & flaring → fast, almost all methane removed, but not energy recovery.
- c) Mix:
 - Short term: remove almost all the methane in landfills through active collection & flaring.
 - Long term: develop landfill to gas energy projects, making use of the CAPEX invested in the previous step.



Typical passive flare

ACTIVE COLLECTION & FLARING AS AN INTERMEDIATE STEP

INTERMEDIATE STEP

- **CURRENT LANDFILLS**
 - Solution only feasible for landfills.
 - ...and mostly on current ones.
 - No ideal solution (no energy recovery, no ideal methane removal).
- **BUT ... FAST, CHEAP AND EASY**
- **INTERMEDIATE STEP TO MORE COMPLEX SOLUTIONS**
 - All landfill gas to energy projects need a previous biogas collection and a safety flaring....
 - Hence, all the CAPEX would be recovered in any future project.



Typical passive flare

50% REDUCTION LANDFILL METHANE EMISSIONS

▪ TECHNICAL EFFICIENCY

- Emissions for typical LatAm waste: 1,4 Tn CO₂e / Ton waste
- Active collection & flaring emissions reduction: 50%
- No disputes about biogas ownership.
- Even with leachate saturated landfills, methane emissions are removed.
- No need for complex connections to external energy networks.

▪ BUT COUNTRIES WITH WEAK REGULATIONS

- No general regulatory requirement for active collection & flaring.
- Landfill tariffs doesn't cover active flaring.
- Current situation: passive venting with/without passive flares.
- Low efficiency and security issues.

▪ PROPOSAL: ESTABLISH PRICE FOR TON CO₂ REMOVED

- Stronger regulation is needed: compulsory active collection & flaring.
- But lack of economical incentives won't allow for correct methane removal.
- Need for a price for Ton CO₂e.



Typical passive flare

2 - 3 €/ Ton CO₂e

- **VERY COST EFFICIENT CO₂e REMOVAL SYSTEM**
 - Order of magnitude: 2 – 3 €/ Ton CO₂e.
 - Low economical impact: 5 – 10% of LatAm landfills´ tariffs.
- **SHORT TIME LAG**
 - Low CAPEX + low complexity.
 - If economical incentives are well designed → fast implementation.

THANKS