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

EUROPE
€7,680 million revenue
65,300 employees

AFRICA MIDDLE EAST
€1,810 million revenue
12,000 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 vocation of “Resourcing the world” is reflected in our commitments to the sustainable development of people, regions and the planet, in particular:

- **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

**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
715 Treatment Plants in 2013

- 36 Plants Special Waste Recycling
- 54 Chemical physical treatment plants for special waste
- 307 Recycling Plants
- 122 Composting Plant
- 12 Units of Soil Decontamination
- 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

- QUERÉTARO LANDFILL, Querétaro, MÉXICO
- BIOGÁS DOÑA JUANA, Bogotá, COLOMBIA
- SANTIAGO PONIENTE LANDFILL, Santiago, CHILE
- LA BONANZA LANDFILL, Caracas, VENEZUELA
- TIJUQUINHAS LANDFILL, Biguaçu, BRAZIL

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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.

Collection

Flaring

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

Client: UAESP (Bogota´s municipal subsidiary responsible of waste management)

Landfill: Doña Juana (Bogota´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:**
- 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.

Source: EU ETS allowance price chart 2008-2013 via World Bank
LA BONANZA COLLECTION & FLARING

La Bonanza landfill – 4,000 ton/day
(Caracas, Venezuela)
WASTE DISPOSAL CONCESSION 4.000 TONS / DAY

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

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
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.
BIOGAS FLOW: 6,000 Nm³/h @ 55 CH4
PORTOBELLO
DIRECT THERMAL
VALORIZATION

Tijuquinhos Landfill – 1,200 ton/day
(Biguaçu, Brazil)
2008: CERs PROJECT

Client: Landfill privately owned.

Landfill: Tijuquinhas (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 conexion 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 conexion pipeline
- Heat pipes to atomization
- LFG burners for atomization (in case of LFG direct use)
METROGAS
BIOMETHANE PRODUCTION

Santiago Poniente landfill – 2,000 ton/day
(Santiago de Chile, Chile)
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 NOx local emissions that make expensive this alternative.
Biomethanation:

Viability > biogas flow 2.600 Nm3/h.
QUERETARO
ELECTRICITY & CERs

Querétaro Landfill – 1,000 ton/day
(Querétaro, Mexico)
In Mexico private companies cannot sell 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
<table>
<thead>
<tr>
<th>Country</th>
<th>Populat. (millions)</th>
<th>% LatAm</th>
<th>GDP US$ per capita</th>
<th>Landfill tariff (€ / ton)</th>
<th>Electricity price (€ / MWh)</th>
<th>Active collection &amp; flaring compulsory or included in tariff</th>
<th>Ownership of biogas</th>
<th>Leachate treatment compulsory or included in tariff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>205</td>
<td>34%</td>
<td>12.300</td>
<td>20-25</td>
<td>50</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mexico</td>
<td>121</td>
<td>20%</td>
<td>15.900</td>
<td>10</td>
<td>100</td>
<td>No</td>
<td>No general rule</td>
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<tr>
<td>Colombia</td>
<td>48</td>
<td>8%</td>
<td>11.200</td>
<td>10-20</td>
<td>40-50</td>
<td>No</td>
<td>No general rule</td>
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<tr>
<td>Argentina</td>
<td>43</td>
<td>7%</td>
<td>18.700</td>
<td>10</td>
<td>5</td>
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<tr>
<td>Peru</td>
<td>31</td>
<td>5%</td>
<td>11.400</td>
<td>4</td>
<td>15</td>
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<tr>
<td>Venezuela</td>
<td>30</td>
<td>5%</td>
<td>13.600</td>
<td>35</td>
<td>3</td>
<td>No</td>
<td>No general rule</td>
<td>Yes</td>
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<tr>
<td>Chile</td>
<td>18</td>
<td>3%</td>
<td>19.500</td>
<td>10-15</td>
<td>80</td>
<td>No</td>
<td>No general rule</td>
<td>Yes</td>
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<tr>
<td>TOTAL</td>
<td>485</td>
<td>81%</td>
<td>13.800</td>
<td>17</td>
<td></td>
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</tr>
</tbody>
</table>
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.
ACTIVE COLLECTION & FLARING
AS AN 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.
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.
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